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PREFACE

In this edition, Volume 26 No 4, we proudly present articles from animal and veterinary sciences including genetics; reproduction, feed technology, and veterinary. The articles published in this edition are:

"Characterisation of Nano-Calcium Lactate from Chicken Eggshells Synthesized by Precipitation Method as Food Supplement"; "Effect of Broiler Litter Based Complete Feed Fermentation Time on Nutrient Content and *In vitro* Digestibility"; "Quality of Chicken Sausage Fortified with Nano-Calcium Duck Eggshell in Different Vacuum Packaging During Storage at -18°C"; "Effect of Body Condition Score on Reproductive Performance and Chest Girth of Bali cows in Different Rearing Systems"; "Diversity, Nest Preferences, and Forage Plants of Stingless Bees (Hymenoptera: Apidae: Meliponini) from West Halmahera, North Moluccas, Indonesia"; "Effect of Types and Dosages of Foliar Fertilizers on Morphology and Production of *Clitoria ternatea*"; and "Production Efficiency of Poultry Small-Scale Laying Hen in Indonesia"

We extent high appreciation to all peer reviewers who make this journal academically high value. Hopefully, these articles would offer any benefit to readers and the end-users of technological innovation, and attract interests from scientists to contribute their papers to the Indonesian Journal of Animal and Veterinary Sciences.

Chief Editor

Bogor, December 2021

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LIST OF CONTENT

Characterisation of Nano-Calcium Lactate from Chicken Eggshells Synthesized by Precipitation Method as Food Supplement

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ABSTRAK

Prayitno AH, Siswoyo TA, Erwanto Y, Lindriati T, Hartatik S, Aji JMM, Suryanto E, Rusman. 2021. Karakterisasi nano kalsium laktat dari kerabang telur ayam yang disintesis melalui metode presipitasi sebagai bahan suplemen pangan. JITV 26(4):139-144. DOI: http//dx.doi.org/10.14334/jitv.v26i4.2828.

Osteoporosis dapat dicegah dengan mengkonsumsi kalsium laktat. Kalsium yang dikonsumsi pada umumnya berukuran mikro. Kalsium berukuran mikro hanya terserap oleh tubuh sekitar 50% yang dapat mengakibatkan terjadinya defisiensi. Nanoteknologi telah dikembangkan untuk peningkatan absorbsi kalsium dalam ukuran nano. Penelitian ini bertujuan untuk mensintesis nanokalsium laktat dari kalsium oksida kerabang telur ayam dan kalsium oksida komersial melalui metode presipitasi. Sintesis dilakukan dengan mereaksikan larutan 1 mol/L kalsium oksida kerabang telur dan kalsium oksida komersial (kontrol) sebanyak 20 ml dicampur larutan 6 mol/L asam laktat sebanyak 30 ml dengan perbandingan 1:1,5 (v/v) selama 30 menit pada suhu 50°C dan diaduk menggunakan *magnetic stirrer* dengan kecepatan 500 rpm/menit. Etanol 50% ditambahkan sebanyak 20 ml (v/v), dioven pada suhu 105°C selama 72 jam kemudian dihaluskan untuk memperoleh serbuk nanokalsium laktat (NCaL). Karakterisasi NCaL menggunakan *Transmission electron microscopy* (TEM), *X-ray diffraction* (XRD), dan *Fourier transform infrared* (FTIR). Hasil penelitian menunjukkan bahwa kerabang telur ayam dapat disintesis dengan metode presipitasi menjadi NCaL berupa kristal berwarna putih. Karakterisasi dengan XRD menunjukkan bahwa sudut difraksi 2θ dengan puncak dari NCaL yaitu 9,3800°, 10,3869°, dan 22,9570°. Karakterisasi dengan FTIR diperoleh puncak pada bilangan gelombang dari NCaL yaitu 1.589,34 cm-1. Karakterisasi dengan TEM menunjukkan bahwa ukuran kristal NCaL yaitu sebesar 75 nm.

Kata Kunci: Kerabang telur ayam, Bahan suplemen pangan, Nanokalsium laktat, Metode presipitasi

ABSTRACT

Prayitno AH, Siswoyo TA, Erwanto Y, Lindriati T, Hartatik S, Aji JMM, Suryanto E, Rusman. 2021. Characterisation of nano-calcium lactate from chicken eggshells synthesized by precipitation method as a food supplement. JITV 26(4):139-144. DOI: http//dx.doi.org/10.14334/jitv.v26i4.2828.

Osteoporosis can be prevented by consuming calcium lactate. Calcium that is consumed is generally in a micro-size. Micro-sized calcium is only absorbed by the body by about 50% which can cause deficiency. Eggshells are poultry waste that is rich in calcium and can be used as a cheap source of dietary calcium through nanotechnology. Nanotechnology has been developed to increase calcium absorption. This study aimed to synthesize nano-calcium lactate from chicken eggshells, and commercial calcium oxide by precipitation method. Synthesis was carried out by reacting a solution of 1 mol/L eggshell calcium oxide and commercial calcium oxide (control) as much as 20 ml mixed with a solution of 6 mol/L lactic acids as much as 30 ml with a ratio of 1:1.5 (v/v) for 30 minutes at 50°C at a speed of 500 rpm/minute using a magnetic stirrer. Ethanol 50% was added as much as 20 ml (v/v), oven-dried at 105°C for 72 hours then crushed to produce eggshell nano-calcium lactate (NCaL) powder. Characterisation of NCaL using Transmission electron microscopy (TEM), X-ray diffraction (XRD), and Fourier transform infrared (FTIR). Result showed that NCaL in the form of white crystals could be synthesized from chicken eggshells by precipitation method. Characterization with XRD showed that the diffraction angle was 2θ with the peaks of NCaL, namely 9.3800°, 10.3869°, and 22.9570°. Characterization with FTIR obtained a peak in the wavenumber from NCaL, namely 1,589.34 cm^{-1}. Characterization using TEM showed that the crystal size of NCaL was 75 nm.

Key Words: Chicken eggshell, Food supplement, Nano-calcium lactate, Precipitation method

INTRODUCTION

Calcium is the most abundant reserved nutrient in the human body (Wiria et al. 2020). Lack of calcium in food is a common problem (Brun et al. 2013) that can lead to osteoporosis (Bradauskiene et al. 2017) and bone loss (Wiria et al. 2020). One of the efforts that can be done to prevent osteoporosis is by taking calcium

supplements (Lee et al. 2017; Paschalis et al. 2017). Osteoporosis can be prevented as early as possible by consuming foods rich in calcium such as milk and dairy products (Caroli et al. 2011).

However, people do not usually consume them in appropriate amounts according to clinical guidelines and on the other hand calcium tablet supplements are expensive (Brun et al. 2013). Even though there are other sources of calcium that have the potential to contain higher calcium than milk, namely eggshells. The eggshell is rich in calcium carbonate which is about 96-97% (Intharapat et al. 2013). The economic value and properties of eggshells can be increased through the application of nanotechnology. The chemical precipitation method produced lactate nano-calcium with a particle size of 55 to 100 nm (Li et al. 2009; Wang et al. 2012).

Materials synthesized in nano size have better performance with increasing surface area (Habte et al. 2019). The calcium lactate is widely used as fortification of calcium with a high absorption rate for the food and pharmaceutical industry (Cheong 2016) which is recognized as safe for use as a texturizer and thickener (Catherina et al. 2016), antibacterial (Yuk et al. 2008), and to preserve and prolong. age of processed meat products (Baston & Barna 2013). Nano-sized materials can cause the extract to dissolve easily and have a high absorption efficiency in the intestine (Gunasekaran et al. 2014).

The formation of nanomaterials by precipitation method is considered cheap, easy, environmentally friendly (Habte et al. 2019), and time saving (You & Xu 2021). Nanotechnology has been developed to increase the absorption rate of calcium in the body (Mosaddegh & Hassankhani 2014; Ferraz et al. 2018; Jirimali et al. 2018). Eggshells can be purified as a source of calcium which can be used as a food supplement (Laohavisuti et al. 2021). The eggshell particle size can be optimized through nanotechnology applications. Nano-calcium lactate from chicken eggshells as novelty can be used as a natural source of calcium as a food supplement. However, there is no scientific supporting data on this matter. Therefore, this study aimed to determine the synthesis of nano-calcium lactate from chicken eggshell by precipitation method.

MATERIALS AND METHODS

Eggshell calcium oxide preparation

Preparation of eggshell calcium oxide was done according to Prayitno et al. (2016). The brown chicken eggshell was cleaned from the eggshell membrane and washed. Eggshells were boiled for 2 hours then oven-dried at 95°C for 24 hours. The dried eggshells were ground and sieved (80 mesh filter size). The powder was then calcined at 1,000°C for 2 hours to gain calcium oxide (CaO) powder.

Nano-calcium lactate preparation

This study compared the synthesis of nano-calcium lactate using brown chicken eggshell calcium oxide and commercial calcium oxide (control) obtained from the Integrated Research and Testing Laboratory (LPPT) Universitas Gadjah Mada. Synthesis of nano-calcium lactate by precipitation method according to Prayitno et al. (2016). A solution of 1 mol/L eggshell CaO and commercial CaO (control) 20 ml mixed with a solution of 6 mol/L lactic acids as much as 30 ml with a ratio of 1:1.5 (v/v) for 30 minutes at 50°C at a speed of 500 rpm/minute using a magnetic stirrer. Ethanol 50% was added as much as 20 ml (v/v), dried in an oven at 105°C for 72 hours then crushed to produce eggshell nano-calcium lactate (NCaL) powder.

Characterization of nano-calcium lactate

The NCaL characterization tested included Fourier transform infrared (FTIR) and X-ray diffraction (XRD) according to Dheyab et al. (2020), and Transmission electron microscopy (TEM) according to Nguyen et al. (2018).

RESULTS AND DISCUSSION

Fourier transform infrared

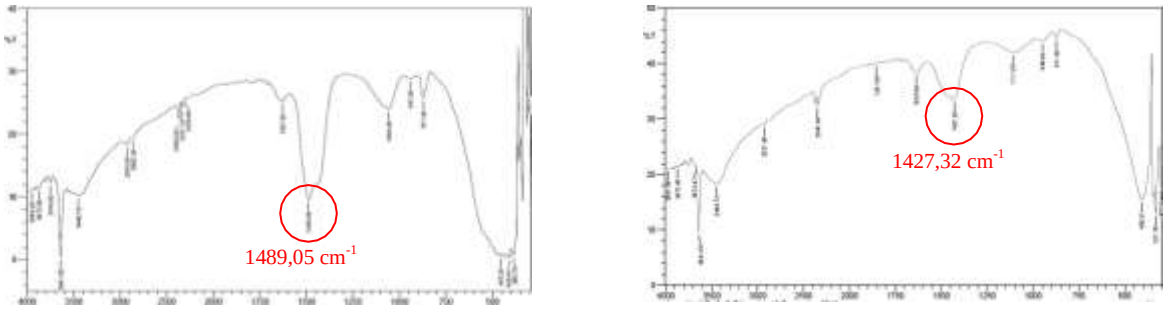
There are three types of physical characterization methods of nanoparticles, namely crystallography, microscopy, and spectroscopy methods. Crystallography using X-rays is very useful for identifying isomorphic crystals, namely crystals that have the same structure but differ in their geometric patterns. Characterization by spectroscopy can use emission photos, magnetic resonance spectroscopy, Fourier transform infrared (FTIR), and X-ray diffraction (XRD) (Nasrollahzadeh et al. 2019).

FTIR is used to identify complex groups in compounds but cannot determine the constituent elements of them. In FTIR, infrared radiation is passed through the sample. Some of the infrared radiation is absorbed by the sample and some are transmitted. If the frequency of a specific vibration is equal to the frequency of infrared radiation directing the molecule, the molecule will absorb that radiation. The result on spectrum describes molecular absorption and transmission. This transmission forms a molecular fingerprint of a sample and because it is a fingerprint there are no two unique molecular structures that

produce the same infrared spectrum (Delmifiana & Astuti 2013).

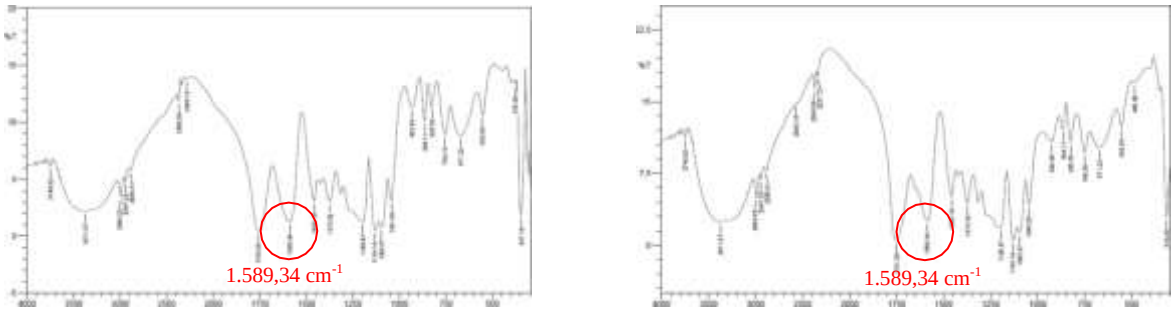
Results of the FTIR test presented in Figure 1 (a) was result of infrared spectroscopy of eggshells that was calcined at 1,000°C. The most mineral content in eggshells is calcium carbonate ($CaCO_3$). Calcium carbonate that was calcined at 1000°C will undergo the decomposition of organic compounds so that the form changes from calcium carbonate to calcium oxide (CaO) (Rivera et al. 1999; Adak & Purohit 2011). This can be seen by the suitability of the location of the wavenumbers between the groups contained in the eggshell which has been heated at 1000°C with the FTIR spectra of commercial calcium oxide as shown in Figure 1 (b). FTIR spectra of eggshells heated at 1000°C are found at wave number 1489.05 cm^{-1} as shown in Figure 1 (a) and approach the FTIR spectra of commercial calcium oxide, namely at wave number 1427.32 cm^{-1} as presented in Figure 2 (b).

The reaction process of calcium lactate from eggshell and commercial calcium oxide with lactic acid has been formed. This can be seen by the suitability of the location of the wavenumbers between the groups contained in calcium lactate based on SDBS as shown in Figure 2 (a), Figure 2 (b), and Figure 3. Figure 3 shows the wavenumber of 1.582 cm^{-1} corresponds to the FTIR spectra of the eggshell calcium oxide which has been reacted with lactic acid, which is found in the wavenumber of 1.589.34 cm^{-1} as shown in Figure 2 (a) and is almost the same as the FTIR spectra of calcium oxide. The commercial calcium oxide that has been reacted with lactic acid has the wavenumber 1,589.34 cm^{-1}



(a) (b)

Figure 1. The location of the wavenumber of calcined eggshells at 1,000°C (a) and commercial CaO (b) measured by FTIR spectra



(a) (b)

Figure 2. The location of the wavenumber of calcium lactate with eggshell CaO (a) and calcium lactate with commercial CaO (b) measured by FTIR spectra

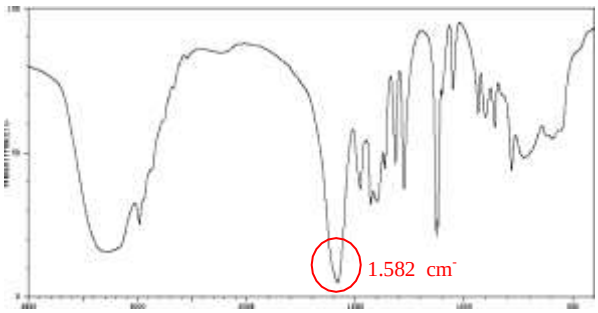
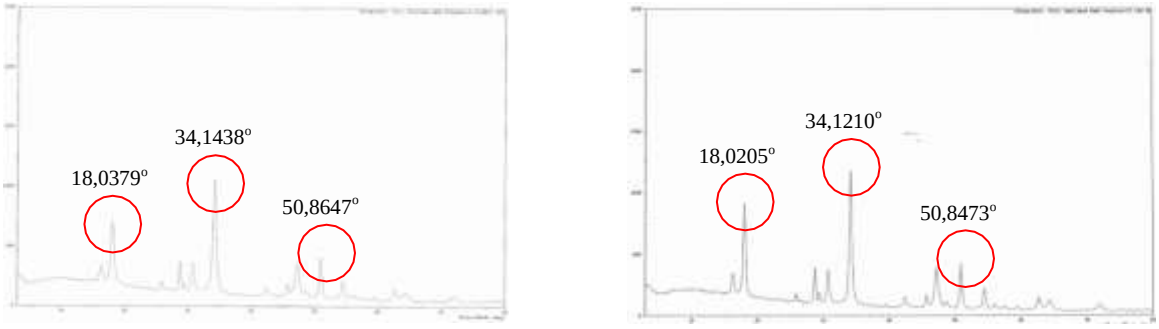


Figure 3. Spectral database (SDBS) cium lactate

as shown in Figure 2 (b). This indicates that both commercial and eggshell calcium oxide which has been reacted with lactic acid has produced calcium lactate.

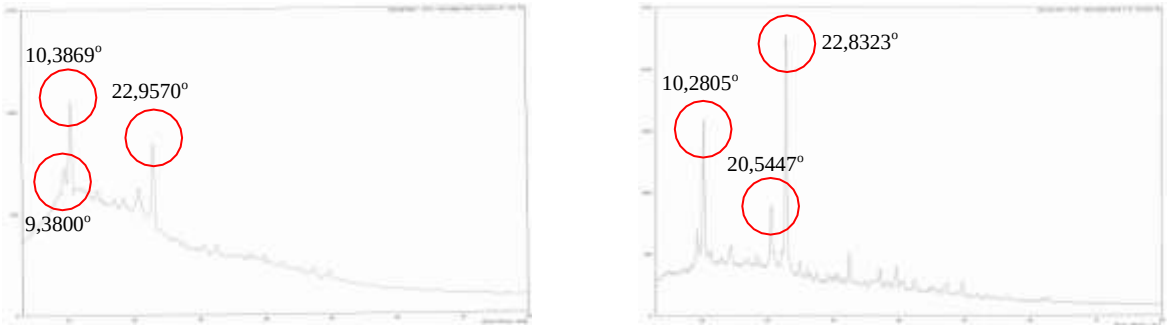
X-ray diffraction

X-ray diffraction (XRD) is used to determine the value of lattice parameters, crystal structure, and degree of crystallinity. The degree of crystallization is a quantity that states the amount of crystal content in a material by comparing the area of the peak curve with the total area of amorphous and crystalline (Fitri et al. 2017). Analysis using the principle of X-ray emission produced by the collision of electrons and atoms of Cr, Fe, Co, Cu, Mo, or W. XRD analysis provide information about the sample structure such as lattice parameters, orientation, and the crystal system. XRD analysis is also useful for identifying semi-quantitative sample phases, by calculating the volume fraction of a sample and the ratio of the crystalline area fraction to the total area fraction (Nasrollahzadeh et al. 2019).



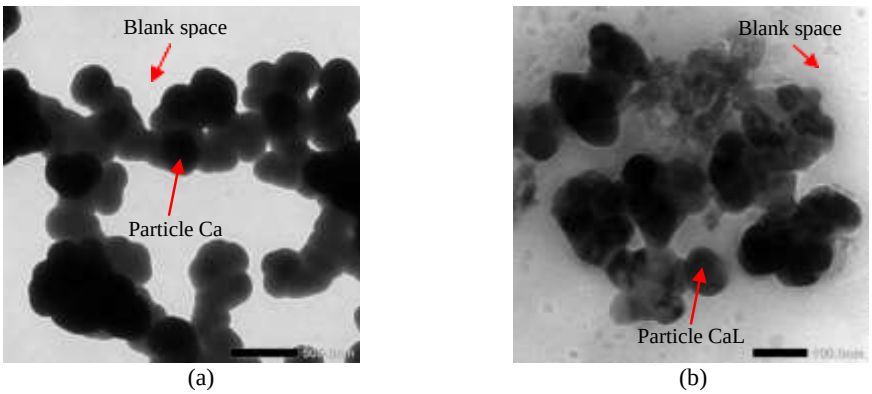
(a) (b)

Figure 4. The diffraction angle of calcined eggshells at 1,000°C (a) and commercial CaO (b).



(a) (b)

Figure 5. The diffraction angle of calcined eggshells at 1,000°C (a) and commercial CaO (b).



(a) (b)

Figure 6. The morphology and ultrastructures of calcined eggshell at 1,000°C with a magnification of 10,000 x (a) and eggshell calcium lactate with a magnification of 40,000 x (b).

XRD results of eggshells heated at a temperature of 1,000°C showed a diffraction angle of 2θ with peaks of 18.0379°, 34.1438°, and 50.8647° as shown in Figure 4 (a) there was a similarity with the peaks of commercial CaO with the diffraction angle of 2θ with peaks 18,0205°, 34,1210°, and 50,8473° as shown in Figure 4 (b). Therefore, the eggshell calcined at 1,000°C has produced calcium oxide. Pongtonglor et al. (2011)reported that $CaCO_3$ from eggshells heated at high temperatures 1,300°C turned into CaO. Calcium carbonate from the eggshell turns into CaO by releasing carbon dioxide (CO_2) as it decomposed (Rivera et al. 1999; Adak & Purohit 2011) as shown in the equation as follow:

$$CaCO_3 \rightarrow CaO + CO_2$$

XRD results of eggshell calcium oxide reacted with lactic acid showed a diffraction angle of 2θ with peaks of 9.3800°, 10.3869°, and 22.9570° as shown in Figure 5 (a). XRD results of commercial calcium oxide reacted with lactic acid showed a diffraction angle of 2θ with peaks of 10.2805°, 20.5447°, and 22.8323° as shown in Figure 5 (b). There are similarities in the two peaks at the diffraction angle of 2θ both in eggshell and commercial calcium oxide which was reacted with lactic acid to form calcium lactate (CaL).

Transmission electron microscopy

The morphology and ultrastructures of eggshell calcium and eggshell calcium lactate are presented in Figures 6 (a) and (b). The uniformity of shape and size of eggshell calcium and eggshell calcium lactate looks the same. The TEM test results showed that the eggshell calcium particle size was known to be about 300 nm as shown in Figure 6 (a).

The TEM test results obtained that the eggshell calcium lactate particle size was 75 nm as shown in Figure 6 (b). Li et al. (2009) and Wang et al. (2012) reported that through the chemical precipitation method, calcium lactate nanoparticles were produced with a particle size of 55 to 100 nm. Abdullah et al. (2008) stated that nanoparticle synthesis means the manufacture of particles with a size of less than 100 nm and at the same time changing their properties or functions.

CONCLUSION

Nano-calcium lactate could be synthesized by the precipitation method form chicken eggshells resulted in white crystals. Characterization with XRD showed that the diffraction angle was 2θ with the peaks of NCaL, namely 9.3800°, 10.3869°, and 22.9570°. FTIR obtained a peak in the wavenumber from NCaL, namely 1,589.34 cm^{-1}. TEM showed that the crystal size of NCaL was 75 nm. The eggshell nano-calcium lactate can be used as a food supplement with a high absorption rate.

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Effect of Broiler Litter Based Complete Feed Fermentation Time on Nutrient Content and *In vitro* Digestibility

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ABSTRAK

Kilimpares NAE, Firzatullah RZ, Andara DI, Mukodiningsih S. 2021 Pengaruh waktu fermentasi pakan lengkap berbasis litter broiler terhadap kandungan nutrien dan kecernaan *in vitro*. JITV 26(4):145-151. DOI: http://dx.doi.org/10.14334/jitv.v26i4.2895.

Limbah litter broiler semakin meningkat seiring terjadinya peningkatan populasi ayam broiler, disisi lain kebutuhan pakan ternak ruminansia semakin bertambah sehingga diperlukannya pakan alternatif berupa *complete feed* berbahan litter. Penelitian bertujuan untuk mengetahui pengaruh lama fermentasi terhadap kandungan nutrisi dan nilai kecernaan *complete feed*. Penelitian menggunakan Rancangan Acak Lengkap dengan 4 perlakukan dan 5 ulangan, Perlakuan T0 = tidak difermentasi; T1 = fermentasi selama 10 hari; T2 = fermentasi selama 24 hari; T3 = fermentasi selama 38 hari. Parameter yang diamati adalah kandungan nutrisi, VFA, NH_3, nilai kecernaan bahan kering dan kecernaan bahan organik secara *in vitro* menggunakan rumen sapi. Hasil penelitian menunjukkan bahwa *complete feed* yang difermentasi dengan starter EM4 2,5% dan probiofeed 5% selama 38 hari (T3) memberikan pengaruh nyata ($P<0,05$) terhadap kandungan nutrisi, kecernaan bahan kering, kecernaan bahan organik, VFA dan NH_3 pada *complete feed*. Perlakuan waktu fermentasi selama 38 hari berpengaruh nyata terhadap kadar abu, lemak kasar, protein kasar, BETN, TDN, kecernaan bahan kering, kecernaan bahan orgnaik, VFA dan NH_3 tetapi tidak berpengaruh nyata terhadap kadar air dan serat kasar, sehingga *complete feed* bisa dijadikan sebagai pakan alternatif ternak ruminansia mudah didapatkan, murah dan bisa mengurangi pencemaran lingkungan.

Kata Kunci: Pakan Lengkap, Kecernaan, Fermentasi, Litter, Nutrisi

ABSTRACT

Kilimpare, NAE, Firzatullah RZ, Andara DI, Mukodiningsih S. 2021. Effect of broiler litter based complete feed fermentation time on nutrient content and *in vitro* digestibility. JITV 26(4): 145-151. DOI: http://dx.doi.org/10.14334/jitv.v26i4.2895.

Broiler litter waste is increasing as the population of broiler chickens increases, on the other hand the need for ruminant feed is increasing so that alternative feeds are needed in the form of complete feed made from litter. This study was aimed to determine the effect of fermentation time on the nutritional content and digestibility of the complete feed. A completely randomized design with 4 treatments and 5 replications were applied in this study. Treatment T0 = not fermented; T1 = fermentation for 10 days; T2 = fermentation for 24 days; T3 = fermentation for 38 days. Parameters observed were nutrient content, VFA, NH3, dry matter digestibility and organic matter digestibility *in vitro* using cow rumen. Results showed that fermention of complete feed with 2.5% EM4 starter and 5% probiofeed for 38 days (T3) had a significant effect ($P<0.05$) on nutrient content, dry matter digestibility, organic matter digestibility, VFA and NH3. The T3 significantly affected ash content, crude fat, crude protein, BETN, TDN, dry matter digestibility, organic matter digestibility, VFA, and NH3 but had no significant effect on water content and crude fiber. It is concluded that the complete feed could be used as alternative feed for ruminants, and it is easy to obtain, cheap and able to reduce environmental pollution.

Key Words: Complete feed, Digestibility, Fermentation, Litter, Nutrient

INTRODUCTION

As Indonesia's cattle population grows, so does the amount of land needed for cattle grazing pastures. This causes the availability of forage to decrease for meeting the needs of livestock productivity so that alternative feeds are needed to overcome these problems. On the other hand, the broiler farming industry is growing along with the increasing public demand. The number of broiler chicken populations in Indonesia has increased from year to year, namely 2017, 2018, 2019 which amounted to 1,922,636,196 broiler, 3,137,707,479 broiler, and 3,149,382,220 broiler (Badan Pusat Statistik 2019). The increasing population of broiler chickens is in line with the increase in chicken waste produced, namely litter which will result

in environmental pollution in the future. Litter is a cage mat on chicken farms that are commonly used to prevent livestock from direct contact with the floor and has a function in heat insulation and absorption of water and ammonia. The components contained in the used litter include excreta, bedding material, feathers, and spilt feed and drinking water, if properly processed will provide benefits to livestock productivity because it has the potential as a source of crude protein with low fiber that can be degraded by the rumen (Elemam et al. 2009)

To overcome litter as a pollutant and lack of forage, it can be done by processing broiler chicken litter waste through a fermentation process. Processing of broiler chicken litter through a fermentation process makes it contain better nutritional value so that it has the potential to be used as an alternative feed for ruminants. This is because broiler litter contains 87.5% dry matter; crude protein 19.2%; crude fibre 27.1%; extract ether 3.33%; ash 26.0% and NFE 24.4% (Akinfala & Komolafe 2011). Litter also contains minerals such as calcium (Ca), magnesium (Mg), iron (Fe), sulfur (S), manganese (Mn), copper (Cu), zinc (Zn), and chlorine (Cl) derived from broilers manure (Yanuartono et al. 2019). However, in broiler chicken litter there is rice husk, with high crude fibre content. The high crude fibre content affects the organic matter content of rice husks so that it can reduce the level of digestibility of the material when consumed by ruminants (Wijayanti et al. 2012).

Fermentation is a method of processing feed ingredients used to improve the quality of materials through the process of decomposition or overhaul of organic matter carried out under anaerobic or facultative anaerobic conditions using microorganisms (Pamungkas 2011). Fermentation in rice husk litter reduce total pathogenic bacteria such as *Enterobacteriaceae*, *Salmonella* sp, *Escherichia coli*, *Campylobacter*, and others. Fermentation produce organic acids and bacteriocins a type of protein that inhibit the growth of pathogenic bacteria (Rustan 2013). Processing of broiler litter through the fermentation process has a good role in increasing the nutritional value and digestibility of the material due to the activity of microorganisms during fermentation so that it has the potential to be used as ruminant feed. Complete feed is one strategy for feeding livestock that aims to maximize the distribution of feed nutrients to minimize feed selection in livestock and microbial fluctuations in the rumen (Munawaroh et al. 2015). This study was aimed to examine the effect of different fermentation lengths on the nutritional content and digestibility of complete feed based on broiler chicken litter. Complete feed based on broiler chicken litter with fermentation technology is expected to be an alternative feed for ruminants to overcome livestock waste pollution.

MATERIALS AND METHODS

This research was conducted in June – September 2021 at the Feed Technology Laboratory, Faculty of Animal Science and Agriculture, Diponegoro University, Semarang. Analysis of nutrient content was carried out at the Laboratory of Nutrition and Feed Science, Faculty of Animal Science and Agriculture, Diponegoro University, Semarang and analysis of bacterial content was carried out at the Medical Laboratory, SMK Theresiana, Semarang.

Materials

Several materials were used in this study including: broiler litter, Lactic Acid Bacteria starter (EM4), proteolytic, lipolytic and lignocellulolytic bacteria (probiofeed), molasses, urea, salt, mineral mix, rice bran, corn straw, coconut meal, curcuma, aquadest, McDougall solution, pepsin HCL solution, CO_2 gas, indicator methyl red and bromcresol green, H_3BO_3 4%, H_2SO_4 0,0055 N, Na_2CO_3 saturated, H_2SO_4 15%, phenolptalin (PP) 1%, NaOH 0,5 N, HCl 0,5 N, vaseline and cow rumen fluid. Meanwhile, the tools used were trash bags, shovels, latex, masks, disk mill machines, analytical scales, fermenter tubes, water baths, ovens, furnaces, desiccators, Whatman 41 filter paper, oil paper, centrifuges, film tubes, Conway dishes, biuret, statif, leitbeig cooler, glass beaker, erlenmeyer, measuring pipette, micro burette, special distilled flask, destruction flask, scissors, blender, plastic tray, label, stove, and stationery.

Method

The method used in this research includes research design, preparation stage, complete feed fermentation stage, data collection and data analysis.

Research design

a completely randomized design (CRD) with 4 treatments and 5 replications was applied in this study. The treatments given were T0: Complete feed not fermented, T1: Complete feed fermented for 10 days, T2: Complete feed fermented for 24 days, T3: Complete feed fermented for 38 days.

Preparation stage

The preparation stage includes the provision of all equipment and materials to be used in the research. Broiler litter was obtained from a close house chicken

coop owned by Fadli Farm, located in Kaligading Village, Boja District, Kendal Regency.

Complete feed fermentation stage

Broiler litter and corn straw were ground individually using a disk mill machine until to size of ±5 cm. Then 50 ml of EM4 (with the number of microbial Lactobacillus casei $1,5\times10^6$ cfu/ml, Saccharomyces cerevisiae $1,5\times10^6$ cfu/ml, Rhodopseudomonas palustris 1×10^6 cfu/ml), 100 g of probiofeed, 150 ml of molasses, and 0,5 g of premix were dissolved into a bucket containing 105 ml of water. Then as much as 500 g of broiler litter, 100 g of rice bran, 345 g of corn straw, 50 g of coconut cake, 50 g of urea, 50 g of salt, and 0,2 g of ginger were put into a bucket and stirred until homogeneously mixed. Furthermore, the litter mixture is watered using a solution that has been made evenly. After thoroughly mixed, all the ingredients are then put into a trash bag and wrapped tightly so that there are no air cavities to create anaerobic fermentation conditions. Trash bags were then labelled according to the treatment (T0, T1, T2 and T3). Furthermore, the fermentation process is stopped by drying in air dry for 3-4 days when the material has undergone a long fermentation according to the treatment. Then the material is finely ground using a disk mill machine to facilitate laboratory testing.

Data collection

The analysis phase includes proximate analysis, dry matter digestibility (DMD), organic matter digestibility (OMD), VFA and NH3. The proximate analysis includes water content analysis using oven drying method, ash content analysis using ashing method using a furnace, crude protein content analysis carried out using the Kjeldahl method, crude fat content analysis using the Soxhlet method and crude fibre content analysis using the method (AOAC 2005). The DMD and OMD analysis stages were carried out by following the procedure (Tilley & Terry 1963). Measurement of VFA using steam distillation technique and measurement of NH3 using the Conway microdiffusion technique (AOAC 2005).

Determination of digestibility and end-product of rumen microbial fermentation was carried out by following the procedure (Tilley & Terry 1963) by weighing a sample of 0.55 – 0.56 g and put into a fermenter tube filled with 40 ml of McDougall's solution and 10 ml of cow rumen fluid. Furthermore, CO_2 gas was added for 15-20 seconds to create an anaerobic atmosphere in the fermenter tube and then incubated in a water bath at 39^{o}C for 48 hours (every 6 hours shaking was done). After 48 hours of incubation, it was centrifuged at 3000 rpm for 10 minutes. The precipitate obtained was then added to 50 ml of 0,2% HCl pepsin solution and incubated again for 48 hours. Then filtered with Whatman 41 filter paper with the help of a vacuum pump and rinsed with 50 ml of distilled water, 50 ml of H_2SO_4, 50 ml of distilled water and 10 ml of alcohol. The filter results were put into a porcelain crucible and then baked at 110^{o}C for 12 hours to calculate the dry matter digestibility. The samples were then kilned at 550^{o}C for 6 hours to calculate the digestibility of the organic matter. The dry matter and organic matter digestibility values were calculated using the following formula:

$$DMD = \frac{\text{DM Sample - (DM Residue - DM Blanko)}}{\text{DM Sample}}$$

$$OMD = \frac{\text{OM Sample - (OM Residue - OM Blanko)}}{\text{OM Sample}}$$

Samples for VFA and NH3 analysis were only incubated in a water bath for 3 hours (every 30 minutes shaking). Analysis of total VFA production was carried out using the steam distillation method following the procedure (AOAC 2005). Calculation of total VFA production is calculated by the formula:

$$\text{Total VFA} = (\text{blank titration} - \text{sample titration}) \times N\ HCl \times \frac{1000}{5}\ mM$$

Analysis of NH3 production or determination of ammonia levels was carried out using the Conway microdiffusion technique following the procedure (AOAC 2005). Calculation of NH3 production is calculated by the formula:

$$N\text{-}NH_3 = (\text{ml } H_2SO_4 \text{ titrant} \times N\ H_2SO_4 \times 1000)\ mM.$$

Data analysis

The data obtained were analyzed using the Analysis of Variance (ANOVA) to test the diversity of the data and if there was a significant effect, continued with Duncan's Multiple Range Test (DMRT) at a 95% confidence level.

RESULTS AND DISCUSSION

Effect of different fermentation time on nutrient content of complete feed

The results in table 1 show that there is an effect of the time of fermentation on the moisture, ash, crude fat

Table 1. Chemical composition and nutritional value of complete feed

Parameter	Treatments			
	T0	T1	T2	T3
	%			
Water	10.13±0.20^{ns}	9.93±0.11^{ns}	10.37±0.35^{ns}	10.58±0.06^{ns}
Ash	25.46±0.29^{b}	28.91±0.35^{a}	28.47±078^{a}	29.42±0.04^{a}
Crude Fat	1.30±0.28^{b}	2.61±0,24^{ab}	2.92±0,46^{ab}	4.13±1.09^{a}
Crude Fibre	18.21±0.65^{ns}	18.76±1.20^{ns}	17.66±0.10^{ns}	16.91±1.30^{ns}
Crude Protein	16.01±0.10^{a}	12.70±0.10^{d}	13.74±0.10^{c}	14.26±0.10^{b}
Nitrogen Free Extract	28.89±0.30^{a}	27.09±0.40^{ab}	26.84±0.36^{ab}	24.7±0.52^{b}
Total Digestible Nutrient	65.08±0.17^{b}	64.95±0.24^{b}	66.35±0.12^{ab}	68.06±0.43^{a}

Different superscripts on the same line indicate significant differences (P<0.05)

and crude protein content of the complete feed, while the crude fibre is not affected by the length of fermentation.

Based on table 1. it is known that the length of fermentation treatment did not significantly affect (P>0.05) water content. The results obtained showed an increasing trend with increasing fermentation time, namely with a water content of 10.58%. Researchers suspect this is due to the activity of microorganisms that make the water content in each treatment increase during the fermentation process. According to Hilakore (2008) in the fermentation process, the water content is utilized by microbes for the process of transporting nutrients and metabolite products so that the higher the water content, the higher the microbial activity. This is in accordance with the opinion of Hamid et al. (1999) which states that the high-water content produced in the fermentation process can occur due to the long fermentation time that supports the activity of molds in reforming nutrients as energy formation with by-products in the form of metabolites, alcohol, acid, CO_2 and water.

The long fermentation time had a significant effect (P<0.05) on increasing the ash content of the complete feed. The increase in ash content from treatment T0 to T3 occurred as a result of a decrease in crude fiber content. According to Aang et al. (2012) the longer the fermentation time will increase the opportunity for microbes to grow so that the activity of microbial enzymes in breaking down complex bonds into simpler molecules becomes higher as well. The increasing number of these activities will result in the reshuffling of organic matter in large quantities, so that the reduction in organic matter can increase the ash content. This is in accordance with the opinion of Irawan et al. (2012) which states that during the fermentation process, microbes digest a lot of organic matter into simple sugars which will then be used by microbes to support their activities so that in the end the degradation of organic matter by microbes will increase. The high ash content indicates that the mineral content is high in the complete fermented feed.

The duration of fermentation treatment on complete feed significantly affected (P<0.05) fat content. The highest fat content was obtained from the T3 treatment with a value of 4.13, while the lowest fat content was obtained from the T1 treatment with a value of 1.30%. These results prove that the longer the fermentation time, the higher the fat content will be. This increase in crude fat content was expected due to an increase in crude protein and a decrease in crude fiber content, causing an increase in the availability of substrates for fatty acid synthesis. This is in accordance with the opinion of Superianto et al. (2018) which states that the fermentation treatment aims to break down complex compounds into simpler ones so that they can be utilized by microbes for their growth as a source of energy in the form of VFA (Vollaile Fatty Acid) in addition to energy from easily digestible carbohydrates. This is supported by the opinion of Saputro et al. (2015) which states that the longer the fermentation time will make the microorganisms continue to grow and develop because of the energy from the high carbohydrate substrate which is converted into fat.

Results of the analysis showed that effect of duration of fermentation on the crude fiber content of the complete feed was not significant (P>0.05), this was presumably because the length of the fermentation time for each treatment did not provide enough time for microbes to degrade crude fiber in the complete feed. According to Aang et al. (2012) that an increase in the length of fermentation time causes an increase in the opportunity for microbes to grow and ferment, so the longer the fermentation time at a certain time, the higher the chance for microbes to degrade the fermented material. However, seen from the results of the percentage

decrease in crude fiber content in each treatment, the highest crude fiber content was obtained from treatment T1 with a value of 18.76%, while the lowest fiber content was obtained from treatment T3 with a value of 16.91%. According to Semaun & Novieta (2016) that the activity of cellulase enzymes produced by cellulolytic microbes can hydrolyze cellulose into simple compounds. The decrease in crude fiber content during fermentation was due to lignocellulolytic bacteria producing lignocellulase enzymes (lignase, cellulase and hemicellulase) which function to degrade crude fiber. The decrease in crude fiber in complete feed fermentation was due to the activity of the lignocellulase enzyme complex which degrades lignocellulosic compounds into their constituent components. This is supported by Sarkar et al. (2011) which states that lignocellulosic compounds can be completely degraded by the synergistic activity of the lignocellulase enzyme complex produced by certain microbes.

Treatment duration of fermentation showed a significant effect (P<0.05) on crude protein content in complete feed. The crude protein content in the complete feed continued to increase along with the length of the fermentation process (T1, T2, T3). This increase occurred due to the growth of microorganisms along with the length of the fermentation process as a source of microbial protein. According to Orskov (1988) the production of microbial protein is interrelated with the fermentation process and is supported by the opinion of Syahrulawal et al. (2016), the amount of protein used by microbes to form rumen microbial protein and fermentation of carbohydrates will affect the efficiency of microbial protein synthesis. The protein content in the control treatment (T0) was the highest value, this is presumably because the control treatment did not undergo a fermentation process so that the urea used was not degraded and analyzed as crude protein. According to Sumadi et al. (2017) that not only protein will be analyzed as crude protein but also nitrogen that is not derived from protein (NPN).

Content of Nitrogen Free Extract (NFE) of fermented litter ofT1, T2, and T3 significantly decreased when compared to unfermented litter (T0) (P<0.05). The decrease in the value of NFE in the fermented litter is thought to be due to the long fermentation time that supports the activity of fermenting microbes in large quantities, causing energy consumption in complete feed for microbial activity to increase. According to Pakpahan et al. (2019), NFE is energy (carbohydrates, sugar, and starch) contained in feed which is needed by microbes for their growth process.

The value of the Total Digestible Nutrient (TDN) content of fermented litter was significantly increased (P<0.05). The data above shows that the TDN content of fermented litter increases with the length of fermentation time, this is due to an overhaul of crude fiber by starter microbes and produces easily digestible carbohydrates so that the TDN value increases. This is following the opinion of Putri & Chuzaemi (2021) that the addition of a starter containing high concentrations of bacteria can increase the TDN value due to the degradation process or the reshuffling of complex bonds in large numbers by bacteria to produce easily digestible carbohydrates, and supported by the opinion of Amrullah et al. (2019) that the increase in TDN value occur due to a decrease in crude fiber content caused by microbial activity during the fermentation process, which reduces the fiber content of the substrate so that its digestibility increases.

Effect of different fermentation time on dry matter digestibility, organic matter digestibility, VFA and NH3 complete feed

The results of the study in table 2 show that there is an effect of fermentation length treatment on dry matter digestibility (DMD), organic matter digestibility (OMD), VFA and NH3 in complete feed. Based on table 2, it is known that the fermentation length for 38 days (T3) showed the highest DMD value of 68.09% and T1 treatment had the lowest DMD value of 58.83%. The high DMD value might be due to the long fermentation time using a starter containing lactic acid, proteolytic, lipolytic, lignocellulolytic, and lactobacillus plantarum bacteria so that microbes have the opportunity to grow and accelerate nutrient breakdown in complete feed until the 38th day. According to Nugroho et al. (2020) the more the addition of inoculum, the more complex bonds will be degraded so that the fermentation process can take place quickly in increasing dry matter digestibility. The higher the resulting DMD value indicates the amount of dry matter that was digested by microbes.

Effect of duration of fermentation on OMD ofcomplete feed was significantly different (P<0.05) among treatments. The OMD value of each treatment of the complete feed is classified as good because this OMD value tends to increase in line with the length of fermentation, from the lowest value of 70.06% in treatment T0 to the highest value on day 38 (T3), which is 75, 37%. Flachowsky & Hennig (1990) stated that the OMD of broiler litter was 50 – 73%. This OMD value describes the amount of nutrient content contained in feed ingredients, in this case, complete feed based on broiler litter can be digested in the digestive system. Based on research by Shahowna et al. (2013) that the value of organic matter digestibility of poultry litter added to feed ranged from 67.35 – 79.79%.VFA (volatile fatty acid) is the final product of the fermentation process which is the main energy source

Table 2. Dry matter digestibility, organic matter digestibility, volatile faty acid and NH_3 Complete feed

Parameter	Treatments			
	T0	T1	T2	T3
	---------- % ----------			
Dry matter digestibility	63.44±1.45^{b}	58.83±1.195^{c}	63.61±3.765^{b}	68.09±0.18^{a}
Organic matter digestibility	70.06±0.62^{b}	70.41±0.645^{b}	73.41±3.75^{ab}	75.37±3.12^{a}
Volatile faty acid	80.00±10^{c}	50.00±10^{bc}	105.00±5^{ab}	135.00±5^{a}
NH_3	9.68±0.715^{a}	4.24±0.495^{b}	4.81±0.35^{b}	5.12±0.055^{b}

Different superscripts on the same line indicate significant differences (P<0.05)

for ruminants. The results of the analysis of total VFA production from complete feed showed an increase in VFA value along with the length of fermentation. The highest VFA value was in the T3 treatment, which was 135 mM, while the lowest was in the T1 treatment, which was 50 mM. Joseph (2020) stated that the normal total VFA production for survival ranges from 80-160 mM. The increase in total VFA production can occur due to the increase in the fermentation process in the rumen as the fermentation length lasts so that the organic matter in the feed which is degraded by rumen microorganisms also increases and increases the total VFA production. According to Wajizah et al. (2015) that the digestibility value and the quality of the fermented ration will affect the amount of VFA produced.

The long fermentation treatment had a significant effect (P<0.05) on the production of NH3. The highest NH3 production was in the T0 treatment, which was 9.68 mM, while the lowest NH3 production was in the T1 treatment, which was 4.24 mM, while the T2 and T3 treatments were not significantly different from the T1 treatment, which were 4.81 mM and 5.12 mM respectively. The results of the analysis showed that the NH3 value was quite good, ranging from 4.24-9.68 mM. According to Badarina et al. (2014), the value of good NH3 production for rumen microbial life ranged from 4-12 mM. The high value of NH3 in the T0 treatment is thought to be because the urea used as a nitrogen source in the manufacture of complete feed has not been degraded by lactic acid bacteria so that the value of the resulting NH3 test increases.

CONCLUSION

Based on the results of the study, it is concluded that the recommended fermentation time is 38 days, because it has a better nutritional value and digestibility. The duration of fermentation had a significant effect on the value of ash content, crude fat, crude protein, dry matter digestibility, organic matter digestibility, VFA, and NH3, but had no significant effect on water content and crude fiber. Complete fermented feed has high dry matter digestibility and organic matter digestibility so that it can be used as an alternative feed for ruminants that is easy to obtain, inexpensive and can reduce environmental pollution.

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Quality of Chicken Sausage Fortified with Nano-Calcium Duck Eggshell in Different Vacuum Packaging during Storage at -18°C

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ABSTRAK

Prayitno AH, Lorenza F, Suparmi, Naafi'yan MH. 2021. Kualitas sosis ayam yang difortifikasi nano kalsium kerabang telur itik dalam kemasan vakum yang berbeda selama penyimpanan suhu -18°C. JITV 26(4):152-157. DOI: http://dx.doi.org/10.14334/jitv.v26i4.2900.

Penelitian ini bertujuan untuk mengetahui pengaruh fortifikasi nano kalsium kerabang telur itik dan jenis kemasan yang berbeda terhadap kualitas sosis ayam. Materi penelitian terdiri dari nano kalsium kerabang telur itik, daging fillet ayam, gula pasir, bawang putih bubuk, garam, lada, tepung tapioka, es batu, minyak, isolate soya protein, sodium tripolifosfat, monosodium glutamat, selongsong kolagen sosis, kemasan *polyethylene*, *nylon*, dan *retort pouch*. Perlakuan fortifikasi nano kalsium kerbang telur yaitu P0 (0%) dan P1 (0,3%) dari total adonan. Perlakuan kemasan vakum yaitu K1 (*polyethylene*), K2 (*nylon*), dan K3 (*retort pouch*). Semua sosis ayam dikemas vakum dan disimpan pada suhu -18°C dengan waktu pengamatan 0 dan 14 hari. Parameter yang diuji yaitu kadar air, nilai pH, bilangan peroksida, dan total plate count. Data hasil uji dianalisis dengan analisis variansi rancangan acak lengkap pola faktorial dan jika terdapat perbedaan yang signifikan (P<0,05) kemudian diuji lanjut dengan uji *Duncan's New Multiple Range Test*. Sosis yang difortifikasi nano kalsium kerabang telur itik dengan kemasan vakum retort pouch merupakan perlakuan terbaik dengan bilangan peroksida terendah pada umur simpan 14 hari. Sosis yang difortifikasi nano kalsium kerabang telur itik dengan kemasan vakum *retort pouch* pada umur simpan 14 hari memiliki kadar air (51,59%), nilai pH (6,83), bilangan peroksida (64,64 meq O_2/kg), dan total *plate count* (3,50 x 10^3 cfu/g).

Kata Kunci: Sosis ayam, Kerabang Telur itik, Fortifikasi, Nano kalsium, Kemasan vakum

ABSTRACT

Prayitno AH, Lorenza F, Suparmi, Naafi'yan MH. 2021. Quality of chicken sausage fortified with nano-calcium duck eggshell in different vacuum packaging during storage at -18°C. JITV 26(4): 152-157. DOI: http://dx.doi.org/10.14334/jitv.v26i4.2900.

This study aimed to determine the effect of fortification of duck eggshell nano-calcium and different types of packaging on the quality of chicken sausage. The sausage was made of duck eggshell nano-calcium, chicken fillet, sugar, garlic powder, salt, pepper, tapioca, ice, oil, soy protein isolate, sodium tripolyphosphate, monosodium glutamate, collagen casing, polyethylene, nylon, and retort pouch packaging. Treatment for fortification of duck eggshell nano-calcium was P0 (0%) and P1 (0.3%) of the total dough. Vacuum packaging treatments were K1 (polyethylene), K2 (nylon), and K3 (retort pouch). All chicken sausages were vacuum-packed and stored at -18°C for 0 and 14 days of observation. Parameters tested were water content, pH value, peroxide value, and total plate count. Data collected were analyzed by analysis of variance in a completely randomized design with factorial patterns and if there was a significant difference (P<0.05) then further tested with Duncan's New Multiple Range Test. Sausage fortified with duck eggshell nano-calcium with vacuum retort pouch packaging was the best treatment with the lowest peroxide value at day 14 shelf life. Sausage fortified with nano-calcium duck eggshell with vacuum retort pouch packaging at day 14 shelf life had moisture (51.59%), pH value (6.83), peroxide value (64.64 meq O_2/kg), and total plate count (3.50 X 10^3 cfu/g).

Key Words: Chicken sausage, Duck eggshell, Fortified, Nano-calcium, Vacuum-packaged

INTRODUCTION

Age and gender are the factors that affect the daily calcium requirement of the human body. Calcium needs of children 600 mg/day, adults 800 mg/day up to 1,000 mg/day (Justicia et al. 2012). Calcium deficiency in children causes rickets while in adults it can cause osteomalacia and osteoporosis (Deborah et al. 2016). Sources of calcium in food are obtained from milk, vegetables, and fish. But not all calcium from these foods can be directly utilized by the body because there are factors that can increase or decrease calcium absorption. Milk is recommended as the best source of calcium, but milk is still expensive for some people and some people are lactose intolerant, meaning they cannot digest lactose or the natural sugar found in milk and

other dairy products. Whereas there are other sources of calcium that have the potential to contain higher calcium when compared to milk, namely eggshells. Eggshells contain 94-97% calcium carbonate (Nurlaela et al. 2014). Duck eggshells are the second most widely source of calcium produced in Indonesia. Duck eggshells can be increased in economic value and physicochemical properties through the application of nanotechnology into calcium nanoparticles.

The particle size of calcium in duck eggshells can be changed from 13,229 nm to 347 nm with high energy ball milling (Prayitno & Sutirtoadi 2019; Prasetyo & Prayitno 2021) with a calcium content of around 54.36-59.27% (Prayitno et al. 2020). The small size of nanoparticles can cause the extract to be easily soluble and have a high absorption efficiency in the intestine due to an increase in surface area, whereas calcium is generally micro-sized calcium. Nano-calcium oxide is one type of metal oxide that has been widely applied as a catalyst (Gopalappa et al. 2012), antibacterial (Roy et al. 2013; Wang et al. 2017), food additives (Prasetyo & Prayitno 2021), and is able to increase solubility and absorption by the body. Nano-sized duck eggshell as a source of natural food calcium is very good as a functional component that can have a positive effect on health.

Prasetyo & Prayitno (2020) and Prasetyo & Prayitno (2021) reported that nano-calcium duck eggshell fortified sausages can improve chemical quality (increase protein content, ash, and calcium) and do not change sensory quality to the level of 0.3%. Sausage is a product made from raw meat that is mashed with or without the addition of other food ingredients and permitted food additives and is inserted into sausage casings with or without a cooking process (SNI 2015). One of the functional foods is sausage enriched with eggshell calcium (Astawan 2011). Research on eggshell calcium fortification in sausage products has been carried out and can prevent osteoporosis in humans (Murota et al. 2010).

People's consumption patterns are currently starting to change due to busyness, the demands of life, the Covid-19 pandemic, so they prefer ready-to-cook and ready-to-eat products, one of which is sausage. Sausage products have a large market share in Indonesia. Sausage is classified as a processed meat product that is stored in frozen conditions because it is perishable when stored at room temperature due to microbial contamination. The growth and development of microbes can be prevented through storage and preservation processes (Yusuf et al. 2016). Sausage products are usually packaged before storage to prevent quality degradation. Packaging is a container that is usually used to protect sausage products and maintain the quality of sausages for a certain time. This type of packaging can prevent damage to the product (Hendrawan et al. 2016). Sausage products can be packaged in polyethylene, nylon, and retort pouch which is thought to be able to maintain quality and longer shelf life without damaging the physical condition and not changing the flavor of the product.

Polyethylene packaging is the most used packaging for packaging sausage products. Polyethylene packaging is easy to obtain, the price is relatively cheap, and has a good ability to protect the product (Moniharapon 2013). Nylon packaging can be used for animal products that are stored at low temperatures and have low permeability to water (Candra & Sucita 2015). Retort bag packaging materials have evolved from being mostly aluminum foil structures to sophisticated multi-layered packaging, high barrier laminates so that food packaged in retort bags tastes much better than canned products (Shah et al. 2017). The advantages of processed foods packaged in retort bags are more accepted by consumers than foods packaged in glass and metal containers because they are lighter, attractive, and end-use convenient. However, there is no supporting data regarding the use of various types of packaging for chicken sausage products enriched by duck eggshell nano-calcium. Therefore, it is necessary to research to determine the effect of fortification of duck eggshell nano-calcium and different types of packaging on the quality of chicken sausage.

MATERIALS AND METHODS

Materials

The material of sausage consisted of chicken fillet, spices, sugar, garlic powder, salt, pepper, tapioca, ice, oil, soy protein isolate (SPI), sodium tripolyphosphate (STPP), monosodium glutamate (MSG), frankfurter, collagen casing, duck eggshell, polyethylene, nylon, and retort pouch packaging.

Methods

This study consisted of several stages, namely duck eggshell nano-calcium processing, sausage processing, vacuum packaging, storaging, sausage quality analysis, and data analysis.

Duck eggshell nano-calcium processing

Processing duck eggshell nano-calcium using high energy ball milling (Prasetyo & Prayitno 2021). Duck eggshells were soaked in hot water for 10 minutes, the eggshell membranes were cleaned, dried at a temperature of 105°C for 12 hours, then mashed using a sample mill. Eggshell flour was calcined at a

temperature of 1,000°C for 2 hours and then further processed using high energy ball milling for 60 minutes to produce calcium nanopowder.

Sausage processing

The formulation of chicken sausage in this study was according to Prasetyo & Prayitno (2021). The chicken sausage formulation consisted of 50% chicken fillet, 16.5% tapioca, 2.5% soy protein isolate, 10.5% oil, 1.2% salt, 0.5% sodium tripolyphosphate, 1.2% garlic, 1% monosodium glutamate, 2% shallot, 2% onion, 0.2% pepper, 0.2% coriander, 0.2% nutmeg, 0.5% sugar, 1% frankfurter, and 10.5% ice. Treatment of duck eggshell nano-calcium fortification was P0 (0%) and P1 (0.3%) of the total sausage dough. Sausage processing begins with the chicken meat cleaned of connective tissue and then ground using a grinder. The ground chicken and oil are mixed using a meat processor. Then add salt, STPP, MSG, SPI, treatment of duck eggshell nano-calcium (0.3%), and half of the ice. All spices are ground, oil, tapioca, and the remaining half of the ice are mixed using a meat processor. Then the sausage mixture is inserted into the sleeve. Raw sausage is then steamed for 60 minutes at a temperature of 60-70°C. After the cooked sausage was cooled, it was vacuum-packed with either: K1 (polyethylene), K2 (nylon), K3 (retort pouch), and stored at -18°C with an observation time of 0 and 14 days.

Sausage quality analysis

Quality of chicken sausage tested was moisture, pH value, peroxide value (AOAC 2019), and total plate count (SNI 2009). Observation time on the quality of chicken sausage was tested on 0, and 14 days shelf life.

Data analysis

The test data were analyzed by analysis of variance in a completely randomized design with a factorial pattern and if there was a significant difference ($P<0.05$) then further tested with Duncan's New Multiple Range Test (Riadi 2014).

RESULTS AND DISCUSSION

Moisture

Moisture of chicken sausage fortified with duck eggshell nano-calcium in different vacuum-packaged during storage at -18°C is presented in Table 1. The results showed that nano-calcium fortification and different types of packaging was significantly affected ($P<0.05$) moisture of sausages at day 14 shelf life, but different shelf-life did not significantly affect ($P>0.05$) moisture of sausages. There was no significant interaction ($P>0.05$) between nano-calcium fortification and different types of packaging during storage at -18°C to the moisture of sausages. Sausage moisture in this study ranged from 47.87-51.59% lower than that of Lengkey et al. (2016) which ranged from 54.70-56.64%. The moisture in this study still meets the standard of moisture of sausage products, which is a maximum of 67% (SNI 2015).

Results showed that sausages without fortification and with fortification of nanocalcium in polyethylene packaging had the lowest moisture compared to all treatments. The highest moisture of sausages is produced from sausages fortified with nano-calcium in retort pouch packaging, which was around 51.14%. This is in accordance with previous research which showed that eggshell calcium fortification can increase the moisture of processed meat products because it has higher water retention and water holding capacity when compared to meat products that are not fortified eggshells (Prayitno 2014; Suryanto et al. 2014; Prayitno et al. 2016).

Table 1. Moisture (%) of chicken sausage fortified with nano-calcium duck eggshell in different vacuum packaging during storage at -18°C

Fortification	Types of Packaging	Shelf Life	
		Day 0	Day 14
P0	K1	49.65	47.87[ab]
	K2	49.65	49.95[ab]
	K3	49.65	47.41[a]
P1	K1	50.69	48.96[ab]
	K2	50.69	50.94[ab]
	K3	50.69	51.59[b]

[a-b]Different superscripts on the same column showed a significant effect ($P<0.05$)

Value of pH

pH value of chicken sausage fortified with duck eggshell nano-calcium in different vacuum-packaged during storage at -18°C is presented in Table 2. Results showed that effect of nano-calcium fortification and different types of packaging was significant different ($P<0.05$) on pH value of sausages at day 0 and 14 shelf life. In addition, different shelf life also significantly affected ($P<0.05$) pH value of sausages. There was no significant interaction ($P>0.05$) between nano-calcium fortification and different types of packaging during storage at -18°C to the pH value.

The pH value in this study ranged from 6.38-7.19. This pH value decreased after 14 days of storage from 6.78 to 6.49. The pH value was influenced by the presence of duck eggshell nano-calcium. The pH value was higher than that of not fortified with duck eggshell nano-calcium. The pH value in this study was still higher than the results of Rahayu et al. (2012) which ranged from 6.00-6.30. A higher pH value of sausage causes the structure of the meat to open up, giving more space for water molecules.

Results showed that sausage with nano-calcium fortification in nylon packaging had the highest pH value followed by sausage packaged in retort pouch and polyethylene, respectively, namely 7.10; 7.01, and 7.00. The pH value is influenced by duck eggshell nano-calcium which contains positively charged ions, namely Ca^{2+}. This is in accordance with previous research which showed that eggshell calcium fortification could increase pH value of processed meat products than unfortified products (Prayitno 2014; Suryanto et al. 2014; Prayitno et al. 2016).

Peroxide Value

Peroxide value of chicken sausage fortified with duck eggshell nano-calcium in different vacuum-packaged during storage at -18°C is presented in Table 3. The results showed that effect of nano-calcium fortification and different types of packaging was significantly different (P<0.05) on peroxide value of sausages at day 0 and 14 shelf life. In addition, different shelf life also significantly affected (P<0.05) the peroxide value. There was no significant interaction (P>0.05) between calcium nano fortification and different types of packaging during storage at -18°C to the peroxide value of sausages.

Table 2. Value of pH of chicken sausage fortified with nano-calcium duck eggshell in different vacuum packaging during storage at -18°C

Fortification	Types of Packaging	Shelf Life	
		Day 0	Day 14
P0	K1	6.38^{aB}	6.17^{bA}
	K2	6.38^{aB}	6.07^{aA}
	K3	6.38^{aB}	6.05^{bA}
P1	K1	7.19^{bB}	6.81^{cA}
	K2	7.19^{bB}	7.01^{dA}
	K3	7.19^{bB}	6.83^{cA}

[a-d]Different superscripts on the same column showed a significant effect (P<0.05). [A-B]Different superscripts on the same row showed a significant effect (P<0.05)

The peroxide value in this study ranged from 34.94 to 88.75 meq O_2/kg. The value of sausages increased after 14 days of storage from 47.42 to 77.45 meq O_2/kg. The rate of increase in sausage peroxide can be slowed down by fortification of duck eggshell nano-calcium and the use of different types of packaging. The peroxide value of sausage fortified with duck eggshell nano-calcium was lower than sausage that was not fortified with duck eggshell nano-calcium. This is because eggshell calcium is known to be used as an absorbent that can reduce the peroxide value in the oil (Fitriana & Safitri 2015).

Results showed that sausages with nano-calcium fortification in retort pouch packaging had the lowest peroxide value followed by sausages packaged in polyethylene and nylon, respectively 49.79; 57.67, and 60.17 meq O_2/kg. Fortification with duck eggshell nano-calcium as an adsorbent has the main component, namely calcium carbonate which is polar. Polar duck eggshell calcium as an adsorbent can adsorb free fatty acids that have a polar carboxyl end (Fitriana & Safitri 2015). The use of retort pouch packaging in layers and high barrier lamination (Shah et al. 2017) can also slow down the oxidation rate of sausages so that the peroxide value of sausages is still relatively lower when compared to all treatments.

Total plate count

Total plate count of chicken sausage fortified with duck eggshell nano-calcium in different vacuum-packaged during storage at -18°C is presented in Table 4. The results showed that effect of nano-calcium fortification and different types of packaging was

Table 3. Peroxide value (meq O_2/kg) of chicken sausage fortified with nano-calcium duck eggshell in different vacuum packaging during storage at -18°C

Fortification	Types of Packaging	Shelf Life	
		Day 0	Day 14
P0	K1	59.91^{b}	75.52^{abc}
	K2	59.91^{bA}	88.75^{dB}
	K3	59.91^{bA}	69.97^{abB}
P1	K1	34.94^{aA}	80.41^{bcdB}
	K2	34.94^{aA}	85.40^{cdB}
	K3	34.94^{aA}	64.64^{aB}

[a-d]Different superscripts on the same column showed a significant effect (P<0.05). [A-B]Different superscripts on the same row showed a significant effect (P<0.05)

Table 4. Total plate count (cfu/g) of chicken sausage fortified with nano-calcium duck eggshell in different vacuum packaging during storage at -18°C

Fortification	Types of Packaging	Shelf Life	
		Day 0	Day 14
P0	K1	2.50×10^{3A}	5.90×10^{3dB}
	K2	2.50×10^{3A}	6.10×10^{3dB}
	K3	2.50×10^{3}	3.60×10^{3c}
P1	K1	2.40×10^{3}	2.30×10^{3b}
	K2	2.40×10^{3}	1.40×10^{3a}
	K3	2.40×10^{3}	3.50×10^{3c}

[a-d]Different superscripts on the same column showed a significant effect (P<0.05). [A-B]Different superscripts on the same row showed a significant effect (P<0.05)

significantly differnt (P<0.05) on the total plate count of sausages at day 0 and 14 shelf life.

In addition, different shelf life significantly affected (P<0.05) total plate count of sausages. There was no significant interaction (P>0.05) between nano-calcium fortification and different types of packaging during storage at -18°C to the total plate count of sausages.

The total plate count in this study ranged from 1.40×10^3 – 6.10×10^3 cfu/g. The total plate count increased after 14 days of storage from 2.45×10^3 to 3.80×10^3. The total plate count could be slowed down by fortifying duck eggshell nano-calcium and the use of different types of packaging. The total plate count of fortified sausage was lower than that unfortified. This is because eggshell nano-calcium is known to be used as an antibacterial agent (Roy et al. 2013) so that it can slow down bacterial growth during storage.

Results showed that sausages with nano-calcium fortification in nylon packaging had the lowest total plate count, followed by sausages packaged in polyethylene and retort pouch, respectively 1.90×10^3; 2.35×10^3; and 2.95×10^3 cfu/g. The total plate count in this study still meets the standard, which is a maximum of 1×10^5 cfu/g (SNI 2015). Fortification of duck eggshell nano-calcium as an antibacterial has the main component, namely calcium oxide (CaO). Nanoparticles have broad-spectrum antimicrobial properties that significantly inhibit the growth and reproduction of bacteria (Wang et al. 2017). In addition, metal oxide compounds in the nanoscale can denature microbial cell walls until they are damaged so that the microbial cells die (Sharmila et al. 2018).

CONCLUSION

Sausage fortified with duck eggshell nano-calcium with vacuum retort pouch packaging was the best treatment with the lowest peroxide value at day 14 shelf life. Sausage fortified with nano-calcium duck eggshell with vacuum retort pouch packaging at day 14 shelf life had moisture (51.59%), pH value (6.83), peroxide value (64.64 meq O_2/kg), and total plate count (3.50×10^3 cfu/g).

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Effect of Body Condition Score on Reproductive Performance and Chest Girth of Bali cows in Different Rearing Systems

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ABSTRAK

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Nutrisi dan sistem pemeliharaan merupakan salah satu faktor utama yang memengaruhi peroduktivitas sapi. Body condition score (BCS) adalah metode yang digunakan untuk menilai status nutrisi dan mengevaluasi sistem pemeliharaan tiap individu ternak. Penelitian ini bertujuan untuk menganalisis pengaruh dan hubungan antara BCS terhadap performa reproduksi dan lingkar dada sapi Bali pada sistem pemeliharaan yang berbeda. Penelitian ini dilakukan di Stasiun Lapang Sekolah Peternakan Rakyat (SL-SPR) Kuamang Abadi, Kabupaten Bungo, Jambi, Indonesia. Materi yang digunakan adalah 62 ekor sapi bali dengan kategori nilai BCS 2, 3 dan (skala 1-5) yang dipelihara pada sistem intensif semi-intensif dan ekstensif. Penelitian dilakukan dengan metode survey dan observasi langsung. Variabel yang diamati adalah BCS, jarak beranak (CI), masa kosong (DO), service per conception (S/C) dan lingkar dada (LD). Data dianalisis menggunakan analisis korelasi dan regresi sederhana dengan software SPSS, kemudian dianalisis secara deskriptif. Hasil penelitian menunjukkan bahwa BCS sapi bali pada sistem pemeliharaan yang berbeda tidak berpengaruh terhadap CI, DO, S/C dan LD. BCS memiliki koefisien korelasi (r) yang lemah terhadap kinerja reproduksi CI, DO, dan S/C masing-masing 0,09; 0,09 dan 0,08. BCS dan LD memiliki hubungan yang signifikan dengan koefisien korelasi (r) sebesar 0,53. Hasil penelitian disimpulkan bahwa BCS memiliki hubungan positif terhadap CI, DO, S/C dan LD. BCS tidak dapat digunakan sebagai satu-satunya indikator untuk menilai kinerja reproduksi sapi bali yang dipelihara pada sistem pemeliharaan yang berbeda.

Kata Kunci: Sapi bali, *Body condition score*, Lingkar dada, Kinerja reproduksi

ABSTRACT

Sari DAP, Said S, Nahrowi, Priyanto R, Muladno. Effect of body condition score on reproductive performance and chest girth of Bali cattle in different rearing systems. JITV 26(4):158-166. DOI: http://dx.doi.org/10.14334/jitv.v26i4.2886.

Nutrition and rearing systems are some of the main factors affecting productivity of cows. Body condition score (BCS) is a method used to assess nutritional status and evaluate rearing systems of each animal. This study was done to analyze effect of BCS on reproductive performance and chest girth of Bali cow in different rearing systems. This study was conducted at the Field Station of Sekolah Peternakan Rakyat Kuamang Abadi, Bungo Regency, Jambi, Indonesia. A total of 62 heads of Bali cow with BCS of 2, 3, and 4 (scale 1-5) reared on intensive, semi-intensive and extensive systems were used in this study. This study was conducted using survey and direct observation. Variables observed were as follows: BCS, calving interval (CI), days open (DO), service per conception (S/C) and chest girth (CG). Data were analyzed using simple correlation and regression analysis in SPPS, followed by descriptive analysis. Result showed that the BCS of Bali cow in different rearing systems did not affect CI, DO, S/C and CG. BCS had a weak correlation coefficient (r), with the reproductive performance of CI, DO, and S/C at 0.09, 0.09, and 0.08, respectively. In addition, the relationship between BCS and CG was highly significant, with a correlation coefficient (r) of 0.532. Therefore, BCS had a positive relationship with CI, DO, S/C, and CG. Moreover, BCS cannot be used as the only indicator to assess the reproductive performance of Bali cow in different rearing systems.

Key Words: Bali cow, Body condition score, Chest girth, Reproductive performance

INTRODUCTION

The increase in beef cattle population influenced by the calf operating system, in which smallholder farmers dominate. Calves can be produced annually if the dam has an optimal production performance. Nutrition and maintenance systems are the main factors affecting the reproductive performance of dams. Inadequate nutrition will affect energy and hormone balance, body condition scores (BCS), and reproductive performance, such as delayed puberty, sexual maturity, and reproductive development (Shin et al. 2015; Bhatta & Kaphle 2020).

Adequacy of nutrients to support productivity of the dam is closely related to the available energy reserves, which is indicated in the amount of fat in the body. Evaluating the proportion of body fat by

observing the BCS is a practical way to estimate livestock energy reserves. BCS is a method of assessing body condition of livestock visually based on palpation of body fat deposits under the skin around the base of the tail, spine and hips (Nazhat et al. 2021). Changes in BCS conditions are used as a practical tool to monitor energy balance, nutritional status, physiological conditions, health, and growth rate and as a selection indicator to improve reproductive performance and evaluate maintenance systems (Soares & Dryden 2011; Cornelius et al. 2014; Torres et al. 2015; Wang et al. 2019; Souissi & Bouraoui 2020). BCS conditions such as excess fat content in cows tend to cover the reproductive tract, resulting in impaired function of the reproductive organs. On the contrary, low BCS in cows can reduce their ability to synthesize a reproductive hormone that interferes with ovulation.

Bali cattle are a breed of beef cattle, which are kept primarily by smallholder farmers because of their adaptive nature, high fertility, good growth, and high carcass percentage (Purwantara et al. 2012). Bali cattle population contributes 26.9% per year to national meat demand (Fuah et al. 2020). Bali cattle rearing system in smallholder farmers consists of traditional intensive, semi-intensive, and extensive systems. The absence of records and the limited facilities for smallholder farmers cause Bali cattle productivity to be unmeasurable and uncontrollable; therefore, a simple method to assess cattle productivity, including reproductive and production performance, particularly in the dam as calf producers, is necessary

Relationship between BCS, and reproductive and productive performance has been widely reported in dairy cattle (Oba et al. 2013; Aungier et al. 2014; Gruber et al. 2018) and some crossbred cattle (Budiawan et al. 2015; Dwitarizki et al. 2018; Ervandi et al. 2020), but the information of local cattle raised by small holder farmers such as Bali cattle is limited. This study aims to analyze effect of BCS on reproductive performance. The reproductive performance is measured on the basis of the calving interval (CI), days open (DO), service per conception (S/C) and chest circumference (CC) of Bali cow. This result can be used as basis data for breeders to improve the reproductive performance of Bali cow.

MATERIALS AND METHODS

Study area

This research was conducted at the Field Station of Sekolah Peternakan Rakyat Kuamang Abadi, Bungo Regency, Jambi Province, Indonesia. Four villages (Cilodang, Tirta Mulya, Lingga Kuamang, and Sumber Harapan villages) from two districts (Pelepat and Pelepat Ilir) were chosen for data collection. Sampling was conducted on Bali cow owned by smallholder farmers reared in intensive, semi-intensive, and extensive systems in oil palm areas. Bali cow were intensively kept and reared in a pen with cut and carry feeding. The semi-intensive system was carried out by releasing the cattle in the oil palm area from 06:00 a.m. to 5:00 p.m and kept in a pen at night. Meanwhile, cattle raised in extensive systems were released in the palm area without being penned.

Data collection

The methods used in this study included survey and collecting of primary and secondary data. Primary data were obtained by direct observation and interviews with farmers using a questionnaire, whereas secondary data were obtained from data and information of the inseminator. Sixty-two heads of Bali cows reared in intensive, semi-intensive and extensive systems were used in this study. The Bali cows were selected by random sampling with a minimum once of calving, age of 4–10 years, and BCS of 2–4 (scale 1–5). The number of samples is presented in Table 1.

The parameters observed in this study includes BCS, reproductive performance (CI, DO, and S/C), and CG. The BCS was measured by observing and palpating the hips and ribs. In addition, BCS measurement in Bali cow used a scale of 1–5 (1 = four or more ribs are very prominent and visible in the abdomen; 2 = three ribs are visible in the abdoment; 3 = two ribs are visible in the abdomen; 4 = one rib visible in the abdomen; 5 = no ribs are visible in the abdomen) (Soares & Dryden (2011)

Reproductive performance data were obtained from the owner information and inseminator records. CI was obtained by calculating the difference between the dates of two births (first and second calf and so on) (Titterington et al. 2017). DO was obtained from the number of days after calving to conception (Stadnik et al. 2017). S/C was calculated by dividing the number of mating in a group of cattle by the number of pregnant cattle (Suhendro et al. 2013). CG was measured by wrapping a measuring tape on the chest behind the shoulder, which was in accordance with the National Standardization Agency for Indonesia (SNI 2017) procedure.

Data analysis

The data were tabulated on Microsoft Excel 2019 and arranged by BCS category based on different maintenance systems. Then, the data were analyzed using analysis of variance to obtain the mean, standard deviation, and significant difference among variables. The relationship between BCS and CI, DO, S/C, and CG was analyzed by correlation analysis and simple regression using SPSS, followed by descriptive analysis.

Table 1. Number of Bali cow samples based on the body condition score (BCS) at Sekolah Peternakan Rakyat (SPR) Kuamang Abadi, Bungo Regency, Jambi Province, Indonesia

BCS	Number of sample (heads)			Total (heads)
	Intensive	Semi-intensive	Extensive	
2	7	3	3	13
3	15	9	3	27
4	11	5	6	22
Total (heads)	33	17	12	62

RESULTS AND DISCUSSION

Calving interval

Results showed that the BCS in different rearing systems had no significant effect on the CI value ($P > 0.05$, Table 2). Therefore, Bali cow with a BCS of 3 had a shorter CI than those with BCS of 2 and 4 (369.4 ± 33.8 days). In addition, Bali cow with a BCS of 2, which were reared in semi-intensive systems, had a shorter CI than those reared in intensive and extensive systems. Meanwhile, cow with a BCS of 3 reared in the intensive system had the shortest average CI of 364.7 ± 28.2 days. By contrast, the extensive rearing system extended the CI (406.3 ± 70.7 days). In the BCS 4 category, cows reared in a semi-intensi system had a mean CI of 370.8 ± 30.4 days.

In this study, the average CI of Bali cow ranged from 364.7 days to 406.3 days. This result is similar to the average CI of Bali cow in several regions in Indonesia, which ranges from 360.9 days to 457.8 days (Gunawan et al. 2011; Pemayun et al. 2014; Said et al. 2020; Sari et al. 2020). The results showed that BCS and different rearing systems do not significantly affect CI of Bali cow. These results are similar to those of Budiawan et al. (2015) who reported that BCS did not significantly affect Filial Ongole cattle, and those of Tait et al. (2017), who studied Angus and their crosses. Length of CI is strongly influenced by pregnancy and DO. Pires et al. (2013) reported that extended CI tended to incerase BCS of cattle. Dairy cows with a BCS of 3 are more sensitive to oxidative stress (Laubenthal et al. 2017). High BCS can also causes high oxidative stress, resulting in risk for disorders during calving (Gheise et al. 2017). Similarly, cows with a BCS of 4 have longer CI than those with BCS of 2 and 3.

Adequate nutrition before and after parturition is important for subsequent pregnancy. In this study, cows with a BCS of 3, which are kept in an extensive system, had the longest CI of 406.3 days. Cattle reared in extensive systems only rely on forage under oil palm as a source of feed. Hence, they vary in nutrient intake because of different quality and quantities between seasons. This condition causes feed restrictions, particularly in the dry season, causing malnutrition in cows (Gutiérrez et al. 2014). Endrawati et al. (2020) reported that pregnant cows, which are kept under oil palm areas with a single feed of forage, did not meet their nutritional requirements, thus additional nutrients were necessary. Lack of nutrition causes a decrease in body condition, increases post-partum interval to conception, affects ovarian activity and follicular growth, and increases infertility and risk of death in calves (Bindari et al. 2013; Centurión-Castro et al. 2013; Endrawati et al. 2017; Smuts et al. 2019). In addition, weaning time affects length of CI. Sari et al. (2021) reported that cattle reared in grazing areas had a longer weaning time because of the absence of weaning control from the farmer, thereby extending CI.

Days open

The difference of BCS in Bali cow reared in intensive, semi-intensive and extensive maintenance systems did not show a significant effect on the means of DO ($P > 0.05$, Table 3). Bali cow with a BCS of 3 had a shorter DO (84.4 ± 33.8 days) than those with BCS of 2 and 4. In addition, Bali cow with BCS of 2 and 4, which were reared in the semi-intensive system, had the shortest DO, whereas those reared in the intensive system had the longest DO. However, under BCS 3, cattle reared in the intensive system had a shorter DO than those reared in semi-intensive and extensive systems.

In this study, DO of Bali cow ranged from 79.7 days to 121.3 days. These results are not significantly different from DO of Bali cow kept by smallholder farmers as reported by Pian et al. (2020) and Sari et al. (2020), which are 112.5 and 109.2 days, respectively. The average cattle DO in Indonesia ranges from 116.09 days to 149.32 days (Nuryadi & Wahjuningsih 2011; Setyono et al. 2014; Habaora et al. 2019). On the contrary, the normal range of cattle DO is 60–90 days, which is relatively normal if it exceeds 90 days (Ananda et al. 2019). DO is the number of days from calving to subsequent pregnancy (Stadnik et al. 2017). The results showed that cattle reared in extensive systems had the highest DO value, which was similar to CIs.

Table 2. Calving interval (days) of Bali cows in various body condition scores (BCS) and different rearing systems at Sekolah Peternakan Rakyat (SPR) Kuamang Abadi, Bungo Regency, Jambi Province, Indonesia

BCS	Rearing system			Average
	Intensive	Semi-intensive	Extensive	
2	390.0 ± 42.2^{a,x}	365.0 ± 10.0^{a,x}	373.5 ± 40.3^{a,x}	381.0 ± 35.6^{x}
3	364.7 ± 28.2^{a,x}	365.0 ± 22.2^{a,x}	406.3 ± 70.7^{a,x}	369.4 ± 33.8^{x}
4	397.6 ± 67.8^{a,x}	370.8 ± 30.4^{a,x}	385.7 ± 49.6^{a,x}	388.3 ± 55.4^{x}

^{a,b,c} different superscript letters on the same row indicate significant differences ($P < 0.05$). ^{x,y,z} different superscript letters on the same column indicate significant differences ($P < 0.05$)

Table 3. Days open of Bali cows in various body condition scores with different rearing systems at Sekolah Peternakan Rakyat (SPR) Kuamang Abadi, Bungo Regency, Jambi Province, Indonesia

BCS	Rearing system			Average
	Intensive	Semi-intensive	Extensive	
2	105.0 ± 42.2^{a,x}	80.0 ± 10.0^{a,x}	88.5 ± 40.3^{a,x}	95.0 ± 35.6^{x}
3	79.7 ± 28.2^{a,x}	80.0 ± 22.2^{a,x}	121.33 ± 70.7^{a,x}	84.4 ± 33.8^{x}
4	112.6 ± 67.8^{a,x}	85.8 ± 30.4^{a,x}	104.1 ± 49.6^{a,x}	103.3 ± 55.4^{x}

^{a,b,c} different superscript letters on the same row indicate significant differences ($P<0.05$). ^{x,y,z} different superscript letters on the same column indicate significant differences ($P<0.05$). BCS= body condition scores

In the cattle rearing system of smallholder farmers, DO is strongly influenced by postpartum estrus, postpartum mating, and S/C (Agus & Widi 2018). Post-calving is a critical point because cow body scores will decrease to improve nutrition (Souissi & Bouraoui 2020). After calving, cows experience uterine involution, which is the recovery phase of ovarian activity to prepare the uterus and other reproductive organs and the endocrine system to start the estrus cycle, normal reproduction, and subsequent pregnancy. Under normal conditions, uterine involution is around 25–50 days after parturition, which is followed by postpartum estrus (Wathes et al. 2011).

Cows with poor body conditions can cause malfunctions of ovarian activity, thereby affecting the next estrus cycle (Pivko et al. 2012). Moreover, cows with low body conditions during breeding might reduce detection rate of estrus, whereas low body condition in the post-calving period might cause anestrus and anovulatory cycles (Dubuc et al. 2012). Postpartum anestrus is due to a negative energy balance caused by a decrease in BCS, which negatively affects the oocytes released after ovulation, thereby reducing the rate of conception to insemination (Nigussie 2018).

Results showed that cattle with a moderate BCS (3) had an average DO, which was faster than those with a lean body score (2) and fat (4). Bali cows with a BCS of 4 (fat) had the highest average DO of 103.3 days (Table 3). Some research results strongly suggest a BCS of approximately 3–3.5 in cows to obtain ideal reproductive performance (Souissi & Bouraoui 2020). Cows with over conditions increased the risk of metabolic disease, and the possibility of getting pregnant in the first conception is low (Nazhat et al. 2021). Bagiarta et al. (2017) stated that the BCS of cattle depends on the rearing purpose; for fattening purposes, high BCS value was desirable, whereas for breeding purposes, the calves suitable BCS is 3.

Service per conception

Difference in BCS categories of cattle reared in intensive, semi-intensive and extensive maintenance systems did not significantly affect S/C ($P > 0.05$, Table 4). Bali cow with BCS of 3 had the smallest S/C of 1.5 ±1.4 times. In addition, Bali cow reared in a semi-intensive system under the BCS 2, 3, and 4 categories had a mean S/C lower than those reared in intensive and extensive rearing systems. In semi-intensive rearing systems, the higher the condition score, the higher the S/C. Moreover, Bali cow with a BCS of 2 which were reared in semi-intensive system, had the lowest S/C of 1.0 ± 0.5 times, whereas cattle with a BCS of 3, which were reared in the extensive system had a high S/C of 3.0 ± 3.5 times.

S/C is a reproductive performance parameter that shows the number of mating needed to produce one pregnancy. The results showed that the mean S/C of Bali cow with BCS of 2,3, and 4 ranged from 1.0 to 3.0. The average number of services per conception of Bali cattle in Indonesia ranges between 1.2 to 2.5 (Adrial & Mokhtar 2014; Haryanto et al. 2015; Galuh et al. 2020). This condition shows that the S/C of Bali cattle is relatively high. Based on the results, BCS in intensive, semi-intensive, and extensive rearing systems, did not show any difference. However, the cattle with a BCS of

3 had a lower S/C value than those with a BCS of 2 and 4. These results were not significantly different from those of Ervandi et al. (2020) in Brahman cattle. In crossed Ongole cattle (Budiawan et al. 2015), those with a BCS of 2 and 3 had the same S/C value (1.06), whereas those with BCS of 4 had higher S/C value (1.18). Meanwhile, in Simmental crosses (Dwitarizki et al. 2018), cattle with a BCS of 3.5–4.0 had smaller S/C than those with a BCS of 1.5–3.0. Kim & Jeong (2019) reported that maintaining cows with a BCS of 3 using environmental and nutritional management strategies can improve first service conception, thereby reducing production management costs.

The high S/C value of cows in smallholder farms is generally influenced by reproductive management, such as the matting time. Inaccuracy in mating time is usually due to delays in estrus detection caused by a lack of farmer's knowledge or the occurrence of silent heat, thereby causing failure and repeated breeding (Habaora et al. 2019). Silent heat occurs during normal reproductive cycles and ovulation, but it does not show symptoms of estrus because of estrogen hormone, which is released by ovaries. In general, this case often shows thin or fat condition because of the large amount of fat that covers the body (Lim et al. 2015). Delayed conception in the postpartum period will negatively affect the next level of conception and prolong the interval from calving to conception (Nazhat et al. 2021). The number of services per conception also increases as the number of open days increases (Cielava et al. 2017).

Table 4. Service per conception (times) of Bali cows in various body (BCS) condition scores with different rearing systems at Sekolah Peternakan Rakyat (SPR) Kuamang Abadi, Bungo Regency, Jambi Province, Indonesia

BCS	Rearing system			Average
	Intensive	Semi-intensive	Extensive	
2	$2.3 \pm 2.0^{a,x}$	$1.0 \pm 0.5^{a,x}$	$1.9 \pm 1.3^{a,x}$	1.9 ± 1.7^{x}
3	$1.3 \pm 1.1^{a,x}$	$1.3 \pm 0.6^{a,x}$	$3.0 \pm 3.5^{a,x}$	1.5 ± 1.4^{x}
4	$2.7 \pm 3.3^{a,x}$	$1.4 \pm 1.3^{a,x}$	$2.0 \pm 2.4^{a,x}$	2.2 ± 2.7^{x}

^{a,b,c} different superscript letters on the same row indicate significant differences ($P < 0.05$). ^{x,y,z} different superscript letters on the same column indicate significant differences ($P < 0.05$)

Table 5. Chest girth (cm) of Bali cows in various body condition scores (BCS) and different rearing systems at Sekolah Peternakan Rakyat SPR Kuamang Abadi, Bungo Regency, Jambi Province, Indonesia

BCS	Rearing system			Average
	Intensive	Semi-intensive	Extensive	
2	$150.6 \pm 7.2^{a,x}$	$154.0 \pm 11.3^{a,x}$	$154.5 \pm 0.7^{a,x}$	152.1 ± 7.4^{x}
3	$160.5 \pm 7.7^{a,x}$	$159.0 \pm 8.7^{a,x}$	$163.3 \pm 3.5^{a,x}$	160.3 ± 7.6^{y}
4	$167.2 \pm 5.9^{a,x}$	$158.6 \pm 3.6^{a,x}$	$165.3 \pm 5.8^{a,x}$	164.7 ± 6.3^{z}

^{a,b,c} different superscript letters on the same row indicate significant differences ($P < 0.05$). ^{x,y,z} different superscript letters on the same column indicate significant differences ($P < 0.05$)

Table 6. Result of correlation and regression analysis between body condition score (BCS) and reproductive and chest girth of Bali cow at Sekolah Peternakan Rakyat (SPR) Kuamang Abadi, Bungo Regency, Jambi Province, Indonesia

Component	r	R^2 (%)	Regression equation
Relationship between BCS and CI	0.09	0.9	Y = 360.39 + 5.719 X
Relationship between BCS and DO	0.09	0.9	Y = 75.396 + 5.719 X
Relationship between BCS and S/C	0.08	0.7	Y = 1.107 + 0.237 X
Relationship between BCS and CG	0.532^{**}	28.3	Y = 141.127 + 6.058 X

N= the number of sample (heads), CI = calving interval (days), DO = days open (days), S/C = service per conception (times), CG = chest girth (cm), r = coefficient of correlation; R^2 = coefficient determination. **Correlation is significant at the 0.01 level (2-tailed)

Chest girth

Results showed that differences in BCS conditions had a significant effect on the CG ($P < 0.05$) of Bali cow, however no differences in BCS were observed in different rearing systems ($P > 0.05$, Table 5). The larger the BCS score, the larger the CG of Bali cow. Under a BCS of 2 and 3, cow reared in the extensive system had a larger CG than those reared in intensive and semi-intensive systems. By contrast, under a BCS of 4, cattle reared in the intensive system had the largest CG, which was 167.2 ± 5.9 cm.

CG is a strong single variable for predicting body weight in limited rearing systems in smallholder farmers (Katongole et al. 2013). Several studies have reported a high correlation between CG and body weight, which is generally used to assess productivity in heifers, as an indicator of growth, body calculation, puberty, and date of insemination (Paul et al. 2020). Average CG of Bali cow with a BCS of 2,3, and 4 at SPR Kuamang Abadi ranged from 150.6 cm to 167.2 cm (Table 4). This result is greater than the CG of Bali cattle reported by Agung et al. (2018) at Banyumulek Technopark (135.10 cm) and Garantjang et al. (2020) at the Bali Cattle Breeding Station, South Sulawesi (149.46 cm). Based on the CG measurement, Bali cattle with a body score of 2, 3, and 4 can be included in category I based on the Indonesian National Standard of Bali cattle (BSN 2017).

Based on the observations, BCS had a significant effect on CG. The higher the BSC, the higher the CC. Funding is in line with Manzoor et al. (2017), who reported that CG increased with the increase of BCS in Kashmiri cattle. Therefore, BCS can be used as an indicator in assessing livestock productivity. Thorup et al. (2012) reported that BCS and body weight could be important indicators to estimate energy balance and body reserves. Based on variations in BCS in different maintenance systems, no significant difference in CG was observed. However, with regard to the rearing system, the cattle reared in the extensive system have higher CG values than those reared in intensive and semi-intensive rearing systems under a BCS of 2, 3, and 4.

Correlation among BCS, reproductive performance, and CG

The relationship among BCS, CI, DO, S/C and CG was shown in coefficient of correlation (r), coefficient of determination (R^2), and regression equation (Table 6). The results of correlation analysis showed a weak relationship between BCS and reproductive performance parameters, including CI, DO, and S/C at 0.09, 0.09, and 0.08, respectively. In addition, several previous studies on PO cattle, Brahman cross, and Simmental showed a weak correlation between BCS and reproductive performance (Budiawan et al. 2015; Dwitarizki et al. 2018; Ervandi et al. 2020). The weak correlation between BSC and reproductive performance of Bali cow in smallholder farms indicates that BCS cannot be the only major factor determining reproductive performance. The reproductive performance of the dam in smallholder farmers is strongly influenced by reproductive management, such as the weaning and breeding period.

Meanwhile, the relationship between BCS and CG showed a high significant correlation ($P < 0.05$) with the coefficient of correlation (r) of 0.532. Therefore, BCS can be a good indicator to measure the productivity of Bali cow because it has a high correlation with CG which is correlated with body weight. In crossbreed dairy cattle, BCS has a high correlation with body weight (r = 0.7), but the coefficient of determination (R^2) is low (Lukuyu et al. 2016). Verbeek et al. (2012) and Kenyon et al. (2014) reported a positive linear relationship between BCS and CG in the ewe. However, Mchugh et al. (2019) argued that body's energy reserves were not dependent on the size of the skeleton. Furthermore, Van Burgel et al. (2011) reported a weak positive relationship between BCS and CG in ruminants because CG was strongly influenced by rumen volume, which affected stomach contents.

CONCLUSION

Based on the results, BCS has a positive correlation with CI, DO, S/C and CG but it has no significant effect on CI, DO, and S/C in Bali cow reared in intensive, semi-intensive and extensive rearing systems. BCS can be used as an indicator to measure production performance through CG, but it cannot be used to assess reproductive performance of Bali cow.

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Diversity, Nest Preferences, and Forage Plants of Stingless Bees (Hymenoptera: Apidae: Meliponini) from West Halmahera, North Moluccas, Indonesia

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ABSTRAK

Salatnaya H, Fuah AN, Engel MS, Sumantri C, Widiatmaka, Kahono S. 2021. Keragaman, preferensi bersarang, dan tanaman pakan lebah propolis (Hymenoptera: Apidae: Meliponini) dari Halmahera Barat, Maluku Utara Indonesia. JITV 26(4):167-178. DOI: http://dx.doi.org/10.14334/jitv.v26i4.2896.

Survei keragaman lebah propolis, preferensi bersarang, dan tanaman sumber pakannya dilakukan di Kabupaten Halmahera Barat pada 134 lokasi. Penelitian ini bertujuan untuk mengetahui keragaman spesies, pemilihan tempat bersarang dan habitatnya, dan jenis tanaman pakan dominan. Ditemukan tiga jenis lebah propolis, dan spesies yang paling banyak ditemukan adalah *Tetragonula clypearis* (Friese), diikuti oleh *T. sapiens* (Cockerell), dan *T. biroi* (Friese). Berdasarkan karakter morfologi setiap spesies yang ditemukan, dibuat kunci identifikasi spesies. Koloni lebah paling banyak ditemukan pada bagian bangunan (80.39%), diikuti pada wilayah perkebunan (13.73%), dan hutan rakyat (5.88%). Sebagian besar koloni bersarang di rongga batu, bagian rumah, kotak kayu, rongga pohon, batang kayu kering, akar pohon, ruas bambu, dan rongga besi. Jenis tanaman sumber pakan terdiri dari tanaman kehutanan, tanaman perkebunan, tanaman buah-buahan, sayuran, tanaman hias, dan tanaman liar dan semak. Ketiga spesies yang ditemukan merupakan catatan baru di Halmahera Barat. Lebah hidup dalam tempat-tempat berongga yang beragam yang aman bagi koloninya. Lebah memanfaatkan beragam tanaman berbunga dan mengeluarkan resin yang berada di sekitar lokasi sarang.

Kata Kunci: Keragaman, Tanaman pakan, Preferensi bersarang, *Tetragonula* spp., Halmahera Barat

ABSTRACT

Salatnaya H, Fuah AN, Engel MS, Sumantri C, Widiatmaka, Kahono S. 2021. Diversity, nest preference, and forage plants of stingless bee (Hymenoptera: Apidae: Meliponini) from West Halmahera, North Moluccas, Indonesia. JITV 26(4):167-178. DOI: http://dx.doi.org/10.14334/jitv.v26i4.2896.

Survey of stingless bee diversity, nesting preferences, and forage plants was conducted in West Halmahera across 134 collection sites. This research was aimed to determine species diversity, nesting preference and habitat, and dominant forage plants. There were three species found, the most common species being *Tetragonula clypearis* (Friese), followed by *T. sapiens* (Cockerell), and last *T. biroi* (Friese). Based on the morphology characters of each species, the key identification was provided. The most colonies were found in public houses (80.39%), followed by plantations (13.73%), and the community forest (5.88%), respectively. Most colonies nested in stone cavities, parts of the houses, wooden materials, tree trunks, logs, tree roots, bamboo, and sometimes iron cavities. The forage plants consist of forage plantation, crops, fruits, vegetables, ornamental flowers, wild plants and shrubs. The three species found were new record in West Halmahera. Bees lived in various hollow places that were safe for their colony. Bees made use of a variety of flowering plants and secrete resins around the nest site.

Key Words: Diversity, Forage plants, Nesting preference, *Tetragonula* spp., West Halmahera

INTRODUCTION

Stingless bees (Meliponini) are social bees living naturally in tropical and sub-tropical (Michener 2007; Engel & Rasmussen 2021). The group is most diverse in the Neotropical Region, but within the Eastern Hemisphere the tribe is most species-rich across Indonesia, with about 46 species (Kahono et al. 2018). In natural settings species build their nests within tree trunks, broken walls, and under house roofs (Kumar et

al. 2012). The workers collect nectar and pollen from diverse floral sources and concomitantly pollinate these plants and are therefore critical pollinators of natural and agricultural ecosystems (Widhiono et al. 2016). Like honey bees (*Apis* L.), stingless bees produce honey but also produce propolis (Halcroft et al. 2013). Owing to their smaller body sizes and often smaller colony sizes, the volume of honey produced is of a lesser volume than that of *Apis*, stingless bee honey is nonetheless of considerable benefit for human health and is often of higher monetary value (Kumar et al. 2012; Chuttong et al. 2015). There is, however, a considerable geographic bias in our understanding of stingless bee diversity, nesting biology, floral associations, and management practices, with most information deriving from a subset of species from the western islands (Engel et al. 2018). The distribution and biology of species across the eastern islands, particularly those of the Moluccas, eastern Lesser Sunda islands, West Papua, and Papua, remain poorly documented (Engel 2019).

Herein we explored the diversity and biology of stingless bees in West Halmahera District, a district of the North Moluccas where meliponines are known to occur natively and which the indigenous people refer to as *Caka ngau*, *Dadaaka* or *Ofu Gula*. Within the area there is considerable availability and access to an array of floral sources (crop fields, horticultural plants, plantation, as well as the native forest), and these produce nectar, pollen, as well as resins used by the bees. Sampling of bees across the Moluccas has been exceptionally poor and remains one of the highest priority regions for study, and where there are exceedingly few records for stingless bees (e.g., Rasmussen 2008; Engel 2019). *Tetragonula clypearis* (Friese) was recorded from Ambon, but also is well known from New Guinea and Australia (Dollin et al. 1997; Rasmussen 2008); and sundry records exist for *T. sapiens* (Cockerell) and *T. laeviceps* (Smith) (Kahono et al. 2018). From the North Moluccas documentation of stingless bees remains untouched, and native bee pollinators (not only stingless bees) have generally been overlooked despite their critical value for sustainable agricultural development, the cultivation of natural environments, and the management of hives for honey production and economic growth. Research is needed to determine the diversity of all bee species, understand native bee nesting requirements, and their floral relation to local food crops in West Halmahera District. The focus of the present project was to identify the species of stingless bees occurring in the area, explore the nesting preferences of these species, and to provide notes on their observed visitation of regional floral resources. Future research will expand into the other lineages of bees, notably the solitary bee fauna, of the region.

MATERIALS AND METHODS

Location

This research was conducted in West Halmahera District: Jailolo Sub-District, South Jailolo Sub-District, Sahu Sub-District, East Sahu Sub-District, Ibu Sub-District, South Ibu Sub-District, and Tabaru Sub-District.

Observation of stingless bee nesting sites and feed plants

Sampling locations was determined based on a survey of meliponine nest availability, and these locations were marked with a Global Position System (GPS). The bees were collected after nests were found, followed by recording of the coordinates, the nests' general site, and the kinds of vegetation around each location (Figure 1). The nest entrance of each colony was directly observed and photographed. Similarly, the types of forage plants and resin plants were observed directly and photographed, to which we noted the local names, and identified the floral species using Backer & Brink (1963; 1965; 1968), which were then confirmed by the curator of the herbarium

Collection, preservation, and identification of stingless bee specimens

Bees were collected by net from nest entrances (when found), and euthanized in killing jars with cotton dipped in ethyl acetate. Specimens were kept in paper (10 individuals per colony), labeled with the geo-coordinates from where they were sampled, along with the date and time of sampling. Specimens are vouchered in the Entomology Laboratory, Animal Science Division, Centre of Biological Research, Indonesian Institute of Sciences in Bogor, Indonesia.

Specimens were examined using an OptilabTM Leica Wild M3B and Dino Lite AM-423x microscopes (in the Indonesian Institute of Sciences), and with an Olympus SZX12 stereomicroscope (in the University of Kansas Natural History Museum, Lawrence, Kansas, USA). Identifications were based on comparisons and measurements against reference material identified by S.F. Sakagami and other researchers in Bogoriense Zoologicum Museum, Bogor, Indonesia and in the University of Kansas Natural History Museum, Lawrence, Kansas, USA. Given that many species of stingless bees are exceedingly similar, even cryptically so, and sometimes differentiated only by minor metrics or nest architecture, particularly among species of the genus *Tetragonula*, measurements for populations observation also provided. Characters measured were: Body Length (BL), Compound Eye Length (EL),

Compound Eye Width (EW), Genal Area Width (GAW), Compound Eye Range [interocular distance] (ER), Head Width (HW), Antenna Range [intertorular distance] (AR), Labrum Width (LW), Forewing M-Cu Length (M-Cu), Metatibia Length (TL), Wing Tegula (WT), diameter of second Flagellomere (FL), Malar Space (MS).

Figure 1. Collecting localities for stingless bees and floral hosts in West Halmahera District

RESULTS AND DISCUSSION

Species diversity and characters in West Halmahera

Across Halmahera District 134 colonies distributed were found, as follows: 46 colonies in Jailolo Sub-District, 31 in Sahu Sub-District, 19 in East Sahu Sub-District, nine in South Ibu Sub-District, three in Ibu Sub-District, four in Tabaru Sub-District, and 22 in South Jailolo Sub-District. These colonies encompassed three species that were identified as *Tetragonula clypearis*, *T. sapiens*, and *T. biroi* (Friese). The species were distributed as follows: all three species each in Jailolo and Sahu Sub-District; two species each in South Jailolo, Sahu and East Sahu Sub-District (*T. clypearis* and *T. sapiens*); and one species each in Ibu, South Ibu, and Tabaru Sub-Districts (all *T. clypearis*). *Tetragonula clypearis* was the most commonly encountered species in West Halmahera District, with as many as 109 colonies located (81.34%), followed by *T. sapiens* with 21 colonies (15.67%), and four colonies of *T. biroi* (2.99%).

Tetragonula is the genus of stingless bees with the widest range across the Indo-Pacific, and includes species of a small size, typically with five hamuli on the hind wing, with forewing vein M straight and ending bluntly, and with the mesoscutellum projecting posteriorly (Rasmussen et al. 2017; Engel et al. 2018). The genus has been reported from Continental Asia and Sri Lanka (Sakagami 1978), Southeast Asia (Sakagami & Inoue 1985; Engel et al. 2017), the Philippines (Schwarz 1939; Starr & Sakagami 1987), Malaysia (Schwarz 1939; Salim et al. 2012; Kelly et al. 2014), Australia (Dollin et al. 1997; Halcroft et al. 2013), Thailand (Boontop et al. 2008; Engel et al. 2017), and India (Rasmussen 2013; Rathor et al. 2013). In Indonesia, *Tetragonula* has been reported from Sulawesi (Schwarz 1939), East Kalimantan (Syafrizal et al. 2012; 2014), West Sumatera (D.. Putra et al. 2016), Bali (N.S. Putra et al. 2016), Java, Borneo, Ambon, Moluccas, and Papua (Schwarz 1939; Kahono et al. 2018). Extensive surveys of the smaller archipelagos are needed to further explore the distribution of the species and look for endemic populations or additional species.

Three species – *T. clypearis*, *T. sapiens*, and *T. biroi* – were collected from Halmahera with *T. clypearis* the most commonly encountered, followed by *T sapiens* and *T. biroi*. Previous studies showed that broadly across the Moluccas there are additional species of stingless bees, with *Platytrigona keyensis* on Kei Island, *T. clypearis* on Ambon (Rasmussen 2008), and *T. laeviceps* (Smith) and *T. sapiens* (Cockerell) (Dollin et al. 1997; Rasmussen 2008; Kahono et al. 2018), while *T. biroi* was previously only recorded from Sulawesi and Irian Jaya (Suriawanto et al. 2017; Kahono et al. 2018). The three species recently found in West Halmahera were new records from the Northern Moluccas, especially Halmahera Island.

Morphological characteristics of workers in each species are distinct (Figs. 2–4). *Tetragonula clypearis* has a small size with a body length of 3.16 ± 0.19 mm, while *T. sapiens* and *T. biroi* are larger and have body lengths of 3.91 ± 0.06 mm and 4.74 ± 0.21 mm, respectively. Measurement of the characters is provided in Table 1. *Tetragonula clypearis* has variation in body color, and can be pale like *T. minangkabau* (Sakagami and Inoue), and pale with dark (nearly black) stripes, with areas of yellow and black (Figure 2). The mesosoma is black and setae are prevalent, the metatibia is dark brown, and there are six longitudinal setal bands on the mesoscutum (Figure 5C), like that of *T. fuscobalteata* (Cameron). *Tetragonula sapiens* has a black mesosoma and the mesoscutum is setose (Figure 3), while the pleura have white setae but these are not evenly distributed (Figure

5G). The metasoma is dark brown, sometimes with a slight golden hue posteriorly (Figure 3). The mesosoma of *T. biroi* is black with diffuse white setae, the metasoma is blackish brown (Figure 4), and the setae of the pleura are uniform (Figure 5E).

Identification of *Tetragonula* is generally a difficult matter as the species often differ in minor details and several closely related species can be easily confused. Added to this difficulty is the reality that several species have notable variation in size and color, potentially leading to misidentifications when attempting to rely heavily on mere metrics and color patterns (in fact, it is believed that color is a notoriously misleading feature in many species groups of *Tetragonula* and so should be used with caution). *Tetragonula clypearis* in Halmahera was found to have a body length not differing from that reported earlier, 3.2–3.7 mm (Dollin et al. 1997). Nonetheless, the head width was smaller than that found by Dollin et al. (1997), at 1.57 ± 0.03 mm, but the metatibia length effectively equivalent, at 1.46 ± 0.03 mm (Dollin et al. 1997). Eye length differed from populations of *T. clypearis* studied by Dollin et al. (1997), with the Halmahera population measuring at 1.04 ± 0.02 mm. The forewing M-Cu also differed at 0.97±0.04 mm. The overall wing length, including the tegula, was found to be identical to that recorded by Dollin et al. (1997), 3.4 – 3.7 mm. Overall, the metasoma colour was similar to that of *T. fuscobalteata*, blackish brown, but also at times exhibited a more pale colour like *T. minangkabau* with the metatibia darker (Schwarz 1939; Sakagami & Inoue 1985).

Tetragonula sapiens had been reported previously from the Moluccas. Tetragonula sapiens had a similar colour, size, and structure with T. laeviceps (Schwarz 1939; Dollin et al. 1997). The size of our T. sapiens differed slightly from that of the populations studied by Dollin et al. (1997), having a length of 3.6 – 4.2 mm, but colouration was the same (Schwarz 1939). Eye length also differed at 1.28±0.01 mm, but the head width was equivalent to that found by Dollin et al. (1997), with the Halmahera population measuring 1.85±0.03 mm. The forewing M-Cu was larger at 0.97±0.04 mm, while the metatibia length was shorter at 1.80±0.05 mm (Dollin et al. 1997). The Halmahera population of T. biroi was slightly larger than that of Suriawanto et al. (2017) found on Sulawesi, with ours being 4.00–4.17 mm. Other measurements could not be compared as these authors did not record the same metrics, but colour of the mesosoma on Sulawesi was brownish (Suriawanto et al. 2017). It remains to be determined whether these minor variations in proportions and colouration could be correlated with local microhabitat differences such as elevation, surrounding vegetation, humidity fluctuations, food sources, &c. Generally, this remains an underexplored area in meliponine biology, as there is little information on the degree to which regional floral resources, elevations, and habitats have on the development of ecological variations among populations of a stingless bee species, or between species, and how these might ultimately relate to speciation over geological time.

The following dichotomous key provided as an aid to the identification of the species in the region. It is noted with caution that this key is good only for the fauna of Halmahera and should not be used for other islands without confirming the identification of species against reference material (e.g., the first couplet generally distinguishes species of the *carbonaria* species group from others, and while these are sufficient to regionally distinguish *T. biroi*, it would not sufficiently distinguish *T. biroi* from other species of the same species group in areas where other members of the *carbonaria* group occur together).

Key to Species of *Tetragonula* from West Halmahera (based on morphological characters of the worker caste):

1. Mesepisternum sparsely setose in posterior half, contrasting the densely covered anterior half (Figure. 5F, 5G); malar space nearly obsolescent, linear (Figure 5B), length 0.2× (or much less) diameter of second flagellomere 2
   —. Mes- and metepisternum densely and uniformly covered with fine, short setae (Figure 5E); malar space short but distinct (Figure 5A), length nearly 0.5× diameter of second flagellomere ..... *T. biroi* (Friese)
2. Mesoscutum with longitudinal bands of diffuse setae separated by narrow glabrous interspaces (Figure 5C); smaller species, wing length (including tegula) 3.4–3.8 mm ..... *T. clypearis* (Friese)
   —. Mesoscutum evenly setose, without defined bands separated by glabrous interspaces (Figure 5D); larger species, wing length (including tegula) 4.1–4.7 mm ..... *T. sapiens* (Cockerell)

Nesting sites of Tetragonula in West Halmahera

Colonies were found in public areas, plantations, and the forest. Interestingly, most colonies were found in public areas (85.07%), followed by plantations 11.19%, and the forest (3.73%). This result seems counterintuitive, but colonies in forest settings were more difficult to locate owing to the natural defense of stingless bees to obscure their nests (Michener, 2013). 51 colonies were nesting in house foundations (38.06%), followed by 27 colonies (20.15%) in portions

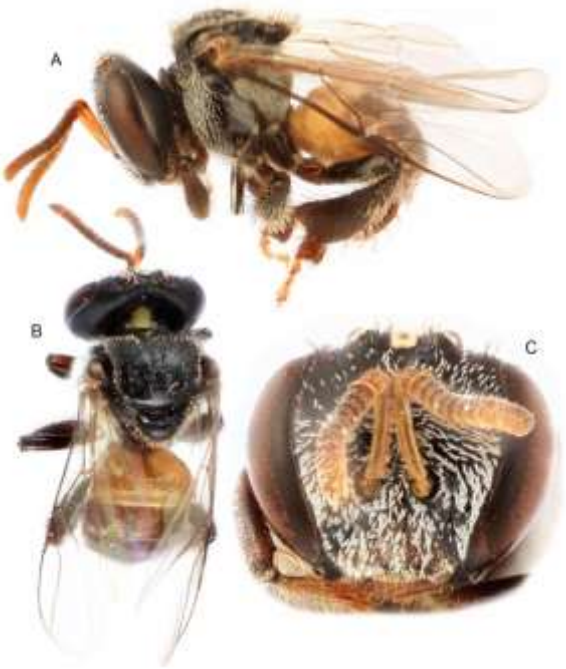

Figure 2. *Tetragonula* (*Tetragonula*) *clypearis* (Friese) from West Halmahera District. A. Lateral habitus. B. Dorsal habitus. C. Facial view.

Figure 3. *Tetragonula* (*Tetragonula*) *sapiens* (Cockerell) from West Halmahera District. A. Lateral habitus. B. Dorsal habitus. C. Facial view.

Figure 4. *Tetragonula* (*Tetragonula*) *biroi* (Friese) from West Halmahera District. A. Lateral habitus. B. Dorsal habitus.

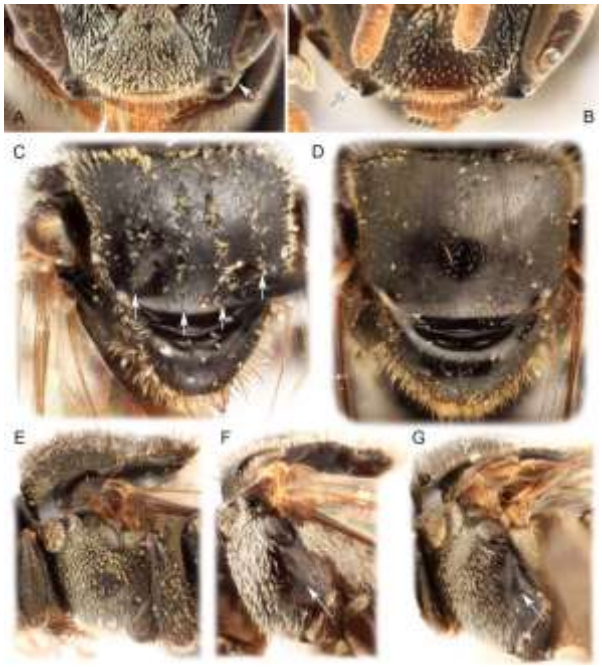

Figure 5. Distinguishing features of species of *Tetragonula* Moure from West Halmahera District. A. Malar space (arrow) of *Tetragonula biroi* (Friese). B. Malar space (arrow) of *T. sapiens* (Cockerell). C.

of houses, 16 colonies (11.94%) in stone cavities, 14 colonies (10.45%) in tree trunks, nine colonies (6.72%) in wooden materials, five colonies (3.73%) in bamboo poles, three colonies (2.24%) in furniture and electrical boxes, two colonies (1.49%) in a log and iron cavity, and one colony (0.75%) in exposed tree roots above the ground.

Mostly colonies of the small species were located, *T. clypearis* (109 colonies), with the 43 nesting sites (39.45%) in house foundations, 27 colonies (24.77%) on parts of houses (e.g., bamboo poles, wooden frames, wall spaces, and even a keyhole), 15 colonies (13.75%) in stone cavities, and 24 colonies (14.68%) in wooden nests, bamboo poles, furniture, electrical boxes, an iron cavity, tree trunk, or log. The prevalence of this species in public spaces may relate to its smaller size, permitting it to occupy cavities too small for the other species and also perhaps permitting them to go more easily unnoticed. *Tetragonula sapiens* had nine colonies (42.86%) in Gufasa (*Vitex coffasus*) trunks, eight colonies (38.10%) in house foundations, and one colony each (4.76 %) in the roots of coconut (*Cocos nucifera*), a log, and exposed roots above the ground, respectively. Three colonies of *T. biroi* (75%) were found living in tree trunks and one colony living in wooden material. These nest locations are tabulated in Table 2.

As in any social arthropod, the nest is critical for defense and establishing a stable and suitable microclimate in which to store resources and develop brood (Nayak et al. 2013). We found that stingless bees in Halmahera live in unpredictable places, similar to that found by prior researchers, and can be found in protected cavities of many sorts, such as walls, logs, live and dead tree trunks, and even sometimes in the ground (Schwarz 1939; Sommeijer 1999; Eltz et al. 2003). Nests of *Tetragonula* were found in Halmahera mostly in settled areas, similar to those in Sulawesi (Suriawanto et al. 2017). Nests were also found at times in cavities of termite nests, buildings, stone, bamboo, wooden walls, iron spaces, pillars, metallic sheaths, water pipes, and brick walls (Jongjitvimol & Wattanachaiyingcharoen 2007; Nayak et al. 2013; Suriawanto et al. 2017). We also found nests in the forest, supported by the previous study in Thailand, with nests of *Tetragonula* in dry dipterocarp forest, upper mixed deciduous forest, lower mixed deciduous forest, and dry evergreen forest (Boontop et al. 2008; Engel et al. 2017). Protected areas were frequently selected for nests, and sometimes they built in the area with food resources nearby, but such factors did not always correlate with nesting site preferences (Nayak et al. 2013).

Forage plants of Tetragonula in West Halmahera

We found 77 species of food plants being used for either nectar and/or pollen and at times also for resins. These floral and resin sources represented nine species of forage plantations, four species of plantation crops, 23 species of fruit plantations, six species of vegetable crops, 22 species of ornamental plants, and 13 wild plants and shrubs (Table 3). Stingless bees require resin in order to construct nests, although bees at resin-producing plants specifically were not documented, nine species of resinous plants at collection localities were located and these are likely suitable sources for these bees. Further study is needed to see if the bees preferentially visit one or more of these resin sources, or if they generally visit any of these plants. In addition, the chemical properties of the resins need to be examined to determine their properties, such as viscosity, acidity, preservative compounds, microbiome, toxins, &c. These factors may render certain resins more or less beneficial as nest components and could potentially relate to preferences on the part of all or some of the species, should such behaviours exist. In addition, it remains to be examined how the bees manipulate the resin and whether there are specific ethologies associated with resin collection in the Tetragonula from Halmahera. Future studies should compare the chemical properties and microbiomes of the nine resin-producing plants in the area with the chemistry of those resins found in nests of the three regional species of *Tetragonula*. A detailed comparison between the microbiome of the bees' intestinal tracts, those of their resins, those of their host plants, and those of their nest storages would be critical for evaluating the role of microbial communities for shaping the ecology of these bees. To date, the microbiome has not been explored in any species of *Tetragonula*.

Worker bees visited many flowers and cared for brood throughout the year (Engel & Dingeman-Bakels 1980). We found various crops, ornamentals, and wild plants used by stingless bees around their nest site. Ramalho et al. (1990) found the same in their study, with their bees visiting various plants from the families Caricaceae, Euphorbiaceae, Fabaceae, Arecaceae, and Rutaceae. The generally small body size of *Tetragonula* allows for workers to visit myriad smaller flowers not visited by larger bees such as *Apis*, *Callomegachile*, and *Amegilla*. Our populations collected resins from at least *Artocorpus heterophyllus* Lam, *Moringa oleifera*, *Mangifera indica*, and *Vinca rosea* L (Roopa et al. 2017), but the association of Halmahera's populations of *Tetragonula* with their resin-producing plants is in need of deeper exploration.

Table 1. Measurements of stingless bees in West Halmahera District in millimeters.

Character	*Tetragonula clypearis*			*Tetragonula sapiens*			*Tetragonula biroi*		
	N	Mean	SD	N	Mean	SD	N	Mean	SD
Body Length (BL)	109	3.16	0.19	21	3.91	0.06	4	4.74	0.21
Compound Eye Length (EL)	109	1.05	0.02	21	1.27	0.01	4	1.22	0.01
Compound Eye Width (EW)	109	0.39	0.01	21	0.50	0.00	4	0.47	0.01
Genal Area Width (GAW)	109	0.20	0.02	21	0.25	0.01	4	0.23	0.00
Forewing M-Cu Length (M-Cu)	109	0.90	0.02	21	1.12	0.01	4	1.16	0.02
Metatibia Length (TL)	109	1.42	0.05	21	1.74	0.01	4	1.68	0.01
Head Width (HW)	109	1.54	0.02	21	1.85	0.01	4	1.85	0.01
Antenna Range (AR)	109	0.15	0.01	21	0.18	0.00	4	0.18	0.01
Labrum Width (LW)	109	0.34	0.02	21	0.44	0.01	4	0.46	0.01
Compound Eye Range (ER)	109	1.05	0.02	21	1.21	0.01	4	1.27	0.02
Wing Tegula (WT)	109	3.25	0.18	21	4.13	0.02	4	4.41	0.02
Diameter of second Flagellomere (FL)	109	0.13	0.00	21	0.15	0.00	4	0.15	0.00
Malar Space (MS)	109	0.03	0.00	21	0.05	0.00	4	0.07	0.00

Table 2. Number of nests by habitat for *Tetragonula* in West Halmahera District

Habitat	Species			Total	Percentage (%)
	Tetragonula clypearis	*Tetragonula sapiens*	*Tetragonula biroi*		
Bamboo	5	0	0	5	3.73
Log	1	1	0	2	1.49
Part of house	27	0	0	27	20.15
Stone cavity	15	1	0	16	11.94
Tree trunk	2	9	3	14	10.45
Root of tree	0	1	0	1	0.75
Foundation	43	8	0	51	38.06
Wooden Materials	8	0	1	9	6.72
Furniture	3	0	0	3	2.24
Electricity	3	0	0	3	2.24
Iron Cavity	2	0	0	2	1.49
Over the land	0	1	0	1	0.75
TOTAL				134	100

Table 3. Forage plants of *Tetragonula* in West Halmahera District

No	Family	Species name	Traditional name	Nectar	Pollen	Resin	Native	Introduced
			Forage Plantation					
1	Araucariaceae	*Agathis* dammara (Lamb.) L.C. Rich[2]	Damar	*	*	*	*	
2	Arecaceae	*Arenga pinnata* (Wurmb) Merr.[2,3]	Aren	*	*		*	
3	Casuarinaceae	*Casuarina* L.[2]	Cemara-cemaraan			*	*	
4	Clusiaceae	*Callophylum inophyllum* L.[1,2,3]	Nyamplung		*	*	*	
5	Euphorbiaceae	*Manihot carthaginensis* subsp. Glaziovii[1,2]	Singkong Karet			*	*	
6	Fabaceae (Mimosacaceae)	*Albizia chinensis* (Osbeck) Merr.[2]	Sengon		*		*	
7	Moraceae	*Artocarpus altilis* (Parkinson) Fosberg[2]	Sukun		*	*	*	
8	Pinaceae	*Pinus* L.[2]	Pinus			*	*	
9	Rubiaceae	*Morinda citrifolia* L.[2]	Mengkudu	*	*		*	
			Crops					
1	Arecaceae	*Cocos nucifera* L.[1,2]	Kelapa	*	*		*	
2	Bombaceae	*Ceiba pentandra* (L) Gaertn[2]	Kapuk Randu	*	*		*	
3	Burseraceae	*Canarium* spp.[2]	Kenari			*	*	
4	Sterculiaceae	*Theobroma cacao* L.[2]	Cokelat	*				*
			Fruits					
1	Anacardiaceae	*Mangifera indica* L.[1,2,3]	Mangga	*	*	*	*	
2	Anacardiaceae	*Spondias dulcis* L.[2]	Kedondong	*	*		*	
3	Anacardiaceae	*Anacardium occidentale* L.[2]	Jambu Monyet		*		*	
4	Annonaceae	*Annona muricata* L.[2]	Sirsak		*		*	
5	Arecaceae	*Salacca zalacca* (Gaertn.) Voss[2]	Salak		*		*	
6	Bombaceae	*Durio zibethinus* murr.[2]	Durian	*	*		*	
7	Cactaceae	*Hylocereus undatus* (Haw.) Britton & Rose[2,3]	Buah Naga Putih	*	*			*
8	Cactaceae	*Hylocereus costaricensis* (F.A.C. Weber) *Britton & Rose*[2,3]	Buah Naga Merah	*	*			*
9	Caricaceae	*Carica papaya* L.[1]	Pepaya	*	*		*	
10	Clusiaceae	*Garcinia* spp.[2]	Manggis	*	*	*	*	
11	Elaeocarpaceae	*Muntingia calabura* L.[2]	Kersen	*	*		*	
12	Lauraceae	*Persea americana* Mill[2]	Alpukat	*	*		*	
13	Meliaceae	*Lansium domesticum* Corr.[2]	Langsat	*			*	
14	Moraceae	*Artocarpus heterophylla*Lmk[2,3]	Nangka		*	*	*	

No	Family	Species name	Traditional name	Nectar	Pollen	Resin	Native	Introduced
15	Moraceae	*Artocarpus integer* (Thumb.) Merr.[2]	Cempedak			*	*	
16	Musaceae	*Musa* sp.[2]	Pisang	*	*		*	
17	Myrtaceae	*Syzgium aquaeum*(Burm. f.) Alston[2,3]	Jambu Air	*	*		*	
18	Myrtaceae	*Psidium guajava* L.[2]	Jambu Biji	*	*		*	
19	Myristicaceae	*Myristica* spp.[1,2,3]	Pala	*	*	*	*	
20	Oxalidaceae	*Averrhoa carambola* L.[2]	Belimbing	*	*		*	
21	Rutaceae	*Citrus microcarpa* Bunge [1,2,3]	Jeruk Kasturi	*	*		*	
22	Sapindaceae	*Nephelium lappaceum*L.[2,3]	Rambutan	*	*		*	
23	Sapindaceae	*Dimocarpus longan* Lour.[1,2]	Lengkeng	*	*			*
		Vegetables						
1	Cucurbitaceae	*Cucurbita moschata* Duschesne[2]	Labu	*	*			*
2	Cucurbitaceae	*Sechium edule* (Jacq.) Swarz[2]	Labu Siam	*				*
3	Euphorbiaceae	*Manihot esculenta* Crantz[2]	Singkong	*	*		*	
4	Poaceae	*Zea mays* L.[2]	Jagung		*			*
5	Solanaceae	*Capsicum frustescens* L.[2]	Cabai rawit	*	*		*	
6	Solanaceae	*Solanum melongena* L.[2]	Terong	*	*			*
		Ornamental Flowers						
1	Amaranthaceae	*Celosia argentea* L.[1,2]	Boroco		*		*	
2	Asteraceae	*Helianthus annus*L.[1,2]	Bunga Matahari	*	*			*
3	Asteraceae	*Tagetes erecta* L.[1,2]	Marigold		*			*
4	Asteraceae	*Zinnia elegans* Jacq.[1,2]	Kembang Kertas		*			*
5	Asteraceae	*Cosmos sulfureus* Cav.[1,2]	Kenikir Sulfur		*			*
6	Cannaceae	*Canna indica* L.[1,2]	Bunga Tasbe		*		*	
7	Cannaceae	*Canna hybrida* Hort.[1,2]	Bunga Tasbe		*		*	
8	Cannaceae	*Canna glauca* L.[1,2]	Aquatic Canna		*		*	
9	Euphorbiaceae	*Jatropha integerrima* Jacq.[1,2]	Jarak batavia	*	*		*	
10	Euphorbiaceae	*Euphorbia milli* Des Moul.[1,2,3]	Mahkota Duri	*	*		*	
11	Euphorbiaceae	*Jatropha multifida* L.[1]	Jarak Cina		*		*	
12	Fabaceae (Caesalpinioideae)	*Caesalpinia pulcherrima* (L.) Sw.[2,3]	Kembang Merak	*	*		*	
13	Fabaceae (Caesalpinioideae)	*Caesalpinia pulcherrima var. flava* Bailey & Rehder[2,3]	Kembang Merak Kuning	*	*		*	
14	Fabaceae	*Calliandra* Benth.[1,2,3]	Kaliandra	*	*			*

No	Family	Species name	Traditional name	Nectar	Pollen	Resin	Native	Introduced
	(Mimosacaceae)							
15	Fabaceae (Mimosacaceae)	*Calliandra surinamensis* Benth.[1,2]	Kaliandra pink		*		*	
16	Malvaceae	*Hibiscus rosa-sinensis plenus*[1,2]	Kembang Sepatu Double		*		*	
17	Malvaceae	*Hibiscus rosa-sinensis* L.[1,2]	Kembang Sepatu		*		*	
18	Plantaginaceae	*Angelonia angustifolia* Benth.[1,2]	Angeloni Ungu		*		*	
19	Portulacaceae	*Portulaca oleracea L.*[1,2,3]	Bunga Pukul 9	*	*		*	
20	Portulacaceae	*Portulaca grandiflora* Hook.[1,2]	Bunga jam 9 double	*	*		*	
21	Rubiaceae	*Ixora coccinea* L.[1,2]	Bunga Asoka		*		*	
22	Turneraceae	*Turnera subulata* J. E. Smith.[1,2,3]	Bunga Pukul 8	*	*		*	
			Wild Plants and Shrubs					
1	Acanthaceae	*Asystasia gangetica* (L.) T. Anderson[2]	Rumput Israel	*	*		*	
2	Acanthaceae	*Ruellia tuberosa* L.[1,2]	Kencana ungu liar		*		*	
3	Asteraceae	*Acmella ciliate* (Kunth) Cass. (Asteraceae)[1,2]	Jotang		*		*	
4	Asteraceae	*Ageratum conyzoides*L.[2]	Bandotan		*		*	
5	Asteraceae	*Cyanthillium cinereum* (L.) H. Rob[2]	Sirangak		*		*	
6	Asteraceae	*Sphagneticola trilobata* (L.) Pruski[2]	Seruni Jalar atau Wedelia		*		*	
7	Capparaceae	*Cleome rutidosperma* DC.[2]	Maman Ungu		*		*	
8	Fabaceae (Mimosacaceae)	*Mimosa pudica* L.[2]	Putri Malu		*		*	
9	Lythraceae	*Cuphea hyssopifolia* Kunth[2]	Taiwan beauty bunga ungu		*		*	
10	Nyctaginaceae	*Boerhavia diffusa* L.[1,2]	Daun Cakaran		*		*	
11	Poaceae	*Eleusine indica* (L.) Gaertn.[2]	Rumput Belulang	*	*		*	
12	Rubiaceae	*Spermacoce confusa* Rendle[2]	Kerekah Batu		*		*	
13	Fabaceae (Mimosacaceae)	*Leucaena leucochepala* (Lam.) de Wit[2]	Lamtoro	*	*		*	

(1) Direct Observation; (2) Reference; (3) Public Information

CONCLUSION

The three species of stingless bees found were new records in West Halmahera. The most common species being *Tetragonula clypearis* (Friese), followed by *T. sapiens* (Cockerell), and last *T. biroi* (Friese). Colonies were mostly found in parts of public houses (80.39%), followed by plantations (13.73%), and the community forest (5.88%), respectively. Most colonies nested in stone cavities, parts of the homes, wooden materials, tree trunks, logs, tree roots, bamboo, and sometimes iron cavities. The dominant forage plants suitable for these bees were forage plantation, crops, fruits, vegetables, ornamental flowers, wild plants and shrubs.

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Effect of Types and Dosages of Foliar Fertilizers on Morphology and Production of *Clitoria ternatea*

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ABSTRAK

Sariffudin AN, Umami N, Suhartanto B, Suwignyo B, Kustantinah. 2021. Pengaruh jenis dan level dosis pupuk daun terhadap morfologi dan produksi *Clitoria ternatea*. JITV 26(4): 179-186. DOI: http://dx.doi.org/10.14334/jitv.v26i4.2912.

Tujuan penelitian adalah untuk mengetahui pengaruh pemberian jenis dan level dosis pupuk daun terhadap morfologi dan produksi tanaman kembang telang. Penelitian dilaksanakan pada bulan September-November 2020 di Kebun Penelitian Hijauan Makanan Ternak dan Pastura, Fakultas Peternakan, Universitas Gadjah Mada, Yogyakarta. Materi yang digunakan adalah bibit kembang telang, pupuk organik cair (POC) kelinci dan pupuk gandasil D. Penelitian dilakukan menggunakan rancangan acak lengkan (RAL) pola faktorial 2x4. Pupuk daun yang digunakan dalam penelitian adalah pupuk organik cair kelinci dan pupuk gandasil D. Level pupuk daun terdiri dari 0; 1,5; 3,0 dan 4,5 g/l/plot. Parameter yang diamati yaitu tinggi tanaman, diameter batang, luas daun, jumlah cabang, produksi segar dan produksi bahan kering tanaman. Data yang diperoleh dianalisis dengan analisis variansi, jika terdapat perbedaan nyata akan diuji lanjut dengan Duncan's New Multiple Test (DMRT) taraf 5%. Hasil penelitian menunjukkan bahwa pemberian jenis pupuk daun tidak berpengaruh nyata terhadap morfologi dan produksi tanaman kembang telang (P>0,05), sedangkan level dosis pupuk berpengaruh nyata (P<0,05) kecuali pada parameter luas daun. Semakin tinggi level dosis pupuk daun yang diberikan diperoleh hasil tinggi tanaman, diameter batang dan jumlah cabang paling maksimal. Perlakuan level dosis pupuk daun 4,5 g/l/plot memperoleh tinggi tanaman, diameter batang dan jumlah cabang tertinggi masing-masing sebesar 160,02 cm, 1,14 cm dan 18,96 cabang. Perlakuan level dosis pupuk 4,5 g/l/plot memberikan produksi segar dan produksi bahan kering tertinggi masing-masing sebesar 19,22 dan 16,75 ton/ha. Kesimpulan dari penelitian ini adalah semakin tinggi dosis pupuk daun yang diberikan, maka beberapa karakter morfologi tanaman, produksi segar dan produksi bahan kering kembang telang juga akan meningkat.

Kata Kunci: *Clitoria ternatea,* Level dosis, Jenis pupuk daun, Morfologi tanaman, Produks

ABSTRACT

Sariffudin AN, Umami N, Suhartanto B, Suwignyo B, Kustantinah. 2021. Effect of types and dosage level foliar fertilizers on morphology and production of *Clitoria ternatea*. JITV 26(4): 179-186. DOI: http://dx.doi.org/10.14334/jitv.v26i4.2912.

The aim of this study was to determine effect of types and dose levels of foliar fertilizers on morphology and production of *Clitoria ternatea*. This study was conducted from September to November 2020 at Forage Research Garden for Animal Feed and Pasture, Faculty of Animal Science, Gadjah Mada University, Yogyakarta. Materials used were *Clitoria ternatea*, liquid organic fertilizer of rabbit and gandasil D fertilizer. This study was designed in a Completely Randomized Design (CRD) with factorial pattern of 2x4. The fertilizer dosages were: 0,1.5,3.0 and 4.5 g/l/plot. The parameters measured were plant height, stem diameter, leaf area, number of branches, fresh and dry matter productions. Data were analyzed by the analysis of variance at 5%, with Duncan's Multiple Range Test (DMRT). Results showed that types of foliar fertilizers did not affect morphological characteristics and production of *Clitoria ternatea* (P>0.05), but the fertilizer dosages had significant effect (P<0.05) on morphological characteristics except for leaf area and production of *Clitoria ternatea*. The higher the dose level of foliar fertilizer the greater the plant height, stem diameter and number of branches. Dosage of 4.5 g/l/plot resulted in the highest plant height, stem diameter and number of branches each 160.02, 1.14 cm and 18.96 branches, respectively. Dosage of4.5 g/l/plot gave the highest fresh and dry matter production of 19.22 and 16.75 tons/ha. It is concluded that increasing the dosage level of foliar fertilizer up to 4.5 g/l/plot resulted in an increased quantity measures of several morphological characteristics and production.

Key Words: *Clitoria ternatea*, Dosage level, Foliar fertilizers, Morphologi, Production

INTRODUCTION

Main source of feed for ruminants is forage such as grass, legumes and agricultural or plantation wastes (Saking & Qomariyah 2017). The main obstacle in providing forage for livestock is its production which is not available throughout the year. This is because the availability of forage is highly dependent on the season.

Indonesia has two seasons: rainy season and dry season. During the rainy season, production of animal feed will be abundant, on the otherhand during the dry season the production will decrease. Most farmers in Indonesia obtain forage from their own gardens, rice fields, roadsides, forest edges and agricultural residues. Meanwhile, forage obtained from intensive planting/cultivation is very limited, in line with the reduction in agricultural or productive land. Productive and fertile land is usually used to grow food crops that have economic value.

Cultivation of leguminous plants as forage for livestock is potential because these plants are able to adapt to various environmental conditions and have good growth rates. Plant growth is the first indicator that dictates the production of a plant high or low. This is because several growth parameters such as plant height, stem diameter, leaf area and number of branches may have a close relationship with plant biomass production. Factors that affect plant growth and development include internal factors (genes and hormones) and external factors (nutrient content, radiation intensity, water content and temperature).

Butterfly pea (*Clitoria ternatea*) is one of leguminous plants that has the potential as animal feed because it has high nutrition and is favored by livestock. *Clitoria ternatea* can grow in various tipes of soil and is resistant to dry conditions and has the best growth when grown in full sun. This plant can still develop during the dry season (Suarna 2005). This plant produce 25-29 tons DM/ha at 42 days of harvest with a protein content of 21,5% (Sutedi 2013). Butterfly pea cultivation in Indonesia so far has not been widely developed by farmers. Farmers prefer the cultivation of superior grasses, considering that the biomass production of grasses is greater than that of legumes. Butterfly pea is a perennial plant so this plant can be harvested several times a year. To maintain stable production of butterfly pea biomass, an effort is needed by means of fertilization.

Plant biomass production can be increased by utilizing foliar fertilizer. The type of foliar fertilizer that is familiar to the community is gandasil D fertilizer which is used when the plant is in the vegetative phase. Gandasil D fertilizer is a chemical fertilizer, if it is not used properly, it will affect plants. Doses that are too high is poisonous (Nuryani et al. 2019). Therefore, the use of the right dose of fertilizer is an important factor during the process of cultivating feed crops. Another alternative to foliar fertilizers is liquid urine from rabbits as leaf fertilizer. Rabbit liquid fertilizer has advantages over liquid fertilizer from other types of livestock, namely the content of N, P and K is higher, so that the nutrient content of fertilizers can be utilized properly by plants, the provision can be applied through the leaves. The N, P and K contents in liquid organic fertilizer of rabbit were 4, 2,8 and 1,2%, respectively (Sembiring et al. 2017). Applications of foliar fertilizer can be given at the time of tillage or given directly. Direct application of foliar fertilizer to plants or often called the foliar application method has several advantages, including faster absorption of nutrients, thereby increasing plant regrowth and affecting plant productivity. Based on the background, this study was aimed to see effect of type and dose level of foliar fertilizer on morphologi and production of butterfly pea (*Clitoria ternatea*).

MATERIALS AND METHODS

Location and time

This research was carried out at the Forage Research Garden for Animal Feed and Pasture, Faculty of Animal Science, Gadjah Mada University in from September to November 2020. Rainfall in the location during the month of September to November, respectively was 21, 52 and 110 mm (BPS 2021). Nutrient content of the research soil is shown in Table 1.

The location

The tools used consisted of a tillage equipment (hoe, sickle or machete), 5 m scale measuring instrument to measure plant height, caliper to measure stem diameter, millimeter block paper to measure leaf area, measuring cup and sprayer each scale 1 L for fertilization, digital scale *Camry* with an accuracy of 0,01 g and a hanging- scale *WeiHeng* with accuracy 1 g for weighing fertilizer doses and forage production at harvest, plastic bags for forage containers at harvest. Materials used in this study were gandasil D fertilizer, liquid organic fertilizer of rabbit, and 96 pieces of butterfly pea plant.

Methods

Experimental design

This study was done based on completely randomized experimental design (CRD) with a factorial pattern of 2x4. The first factor (A) was the type of foliar fertilizer, consisting of liquid organic fertilizer of rabbit urine and gandazil D fertilizer. The second factor (B) was the dose level, consisting of 0 (without fertilizer), 1.5, 3.0 and 4.5 g/l/plot. The treatment combinations were repeated 3 times, so there was a total of 24 plots, with 1 plot consisting of 4 butterfly pea plants.

Fertilization treatment was applied 1 week after the first harvest and was carried out once a week. Fertilizer

Table 1. The content of nutrients in research soil

Nutrient	Unit	Value
pH	-	6.87
C-organik	%	5.49
N-total	%	0.57
P_2O_5	me/100 g	18
K_2O	me/100 g	6
C/N	me/100 g	9.5

Table 2. The content of nutrients in liquid organic fertilizer of rabbit and gandasil D

Nutrient	Liquid organic fertilizer of rabbit*)	Gandasil D**)
N-Total (%)	0.25	20
P-Total (%)	0.18	15
K-Total (%)	0.2	15
Cu-Total (ppm)	20	
Fe-Total (ppm)	1800	
Mn-Total (ppm)	180	

*)Result analysis of laboratory Balingtan (2020)
**)(Palemba et al. 2013)

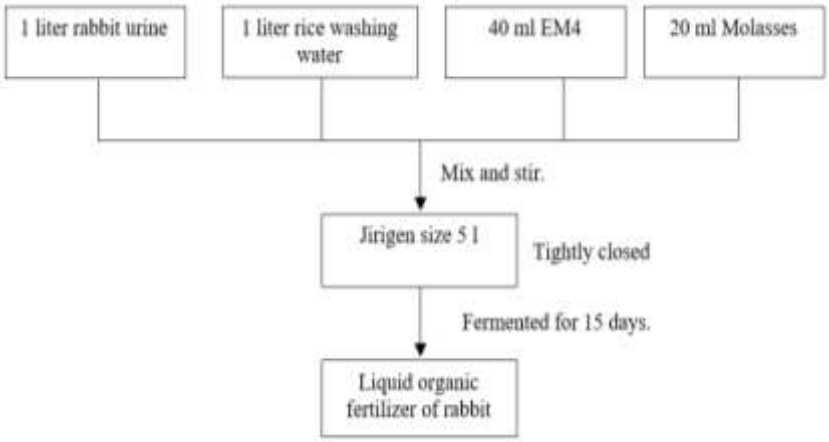

Figure 1. Diagram of making liquid organic fertilizer of rabbit urine

was given by dissolving gandasil D fertilizer, and liquid organic fertilizer of rabbit according to the treatment dose into one liter of water. Fertilizer is given as a foliar application, which means spraying liquid fertilizer directly on plant leaves. Spraying of foliar fertilizer was carried out on the back of the leaf where the stomata are located. Fertilization was carried out at 07.00 – 09.00. Plant maintenance includes watering and weeding. Watering is carried out two times a day in the morning and evening. Weeding was done every time there was weeds presented around the main plant. Observation done including: plant height, stem diameter, and number of branches which were carried out once a week, while observations of leaf area were carried out at harvest. Observations began one week after the first harvest. The second harvesting time was carried out after the plants were 45 days old with a cutting limit of 20 cm from the soil surface. The flow of preparing liquid fertilizer from rabbit urine is shown in Figure 1.

Observed parameters

Parameters observed included plant height, stem diameter, number of branches, leaf area, fresh forage and dry matter production. Plant height was measured with a measuring instrument from the soil surface to the highest growing point (Tanari & Sepatondu 2016). The stem diameter measurement was obtained with a

caliper. Diameter measurement was carried out on the lower stem of the plant about 1 cm above the base of the stem (Usfunan 2016). The number of branches is obtained by counting the total number of branches on the stem of the plant. Leaf area is obtained by drawing leaves on millimeter paper to form a leaf pattern. Leaf area is estimated based on the number of squares in the leaf pattern. The squares inside the leaf pattern are scored one while the squares crossed by the leaf pattern line are scored half. The formula for leaf area according to (Murdaningsih & Wae 2012):

$$LD = n\ x\ Lk$$

where: LD= Leaf area, n= number of square, Lk= area of each box.

Fresh production was obtained from the second harvest. The second harvest was carried out 45 days after the first harvest. Harvesting was done by leaving the stem 20 cm above the soil surface (Syamsuddin et al. 2016). Fresh production data for each plot was weighing the harvest yields, while fresh production (ha) was obtained by converting fresh weight (m^2) to hektare (ha). The dry matter production is obtained by multiplying the fresh production of the plant by the dry matter content of the plant. (Haerudin 2004) stated that total dry matter production can be calculated based on the following formula:

$$\text{Total DM Prod.} = \text{Fresh production x DM Content (\%)}$$

Dry matter content was measured by (AOAC 2005). The test is carried out at least with 2 repetitions.

Statistical analysis

Data were analyzed using analysis of variance, if there was a significant difference it was continued by Duncan's New Multiple Range Test (DMRT) at level 5% performed by IBM SPSS statistic 25.0.

RESULTS AND DISCUSSION

Result showed that the application of different types of foliar fertilizers did not have a significant effect on morphology and production of butterfly pea (*Clitoria ternatea*) (P>0.05), but the fertilizer dose level did affect significantly (P<0.05), except for leaf area. This result shows that there is no interaction between the two factors.

Plant height

Table 3 shows that the type of fertilizer did not significantly affect plant height (P>0,05) while the dose level did significantly affect (P<0,05) it. The dose of 4,5 g/l/plot wasn't significantly different from the treatment of 3 g/l/plot but significantly different from the treatment of 1,5 and 0 g/l/plot, while the dose of 3 g/l/plot was also not different significantly with the treatment of 1,5 and 0 g/l/plot. The highest plant height was achieved by a dose of 4,5 g/l/plot, which was 160,02 cm. The plant height of the butterfly pea plant was obtained according to research by (Gomez & Kalamani 2003) who reported that the plant height of *Clitoria ternatea* could reach 90 – 162 cm and was smaller than that of Arnawa et al. (2017) where the height of the butterfly pea ranges from 178,75 – 220 cm.

The treatment given was able to increase the height of butterfly pea. The higher the level of fertilizer dose given, the more nutrients available to plants. The availability of these nutrients (especially N) can be utilized by plants for growth. The application of foliar fertilizers given by means of foliar application, can also maximize plants in nutrient utilization and fulfillment of nutrient needs so that the rate of photosynthesis can increase. This is in accordance with the opinion of (Ulva et al. 2019) that the increase in the rate of photosynthesis due to the application of foliar fertilizers trigger plant growth, especially the variable of plant height. Butterfly pea height can be influenced by internal and external factors, the most influential external factors are climate and soil factors. According to (Buntoro et al. 2014) that internal and external factors must support each other so that plant growth and development goes well.

Stem diameter

The type of fertilizer did not affect stem diameter of butterfly pea (P> 0,05), while the dose of foliar fertilizer significantly affect (P< 0,05) stem diameter.

Fertilization treatments of 0, 1.5, and 3 g/l/plot were not significantly different, but all three were significantly different from treatment of 4,5 g/l/plot. The highest mean diameter of the stem of the plant was obtained at a dose level of 4,5 g/l/plot which was 1,14 cm. According to (Nugraheni & Paiman 2011), that an increase in the concentration of rabbit urine given affected the stem diameter of tomato plants. The existence of fertilizer dose of 4,5 g/l/plot is thought to be sufficient for plant for vegetative growth. The application of foliar fertilizers affect the vegetative phase of a plant, because the vegetative phase is an important phase in plant growth.

The increase in stem diameter is due to the process of forming new tissue in plants as a result of plants absorbing available nutrients, especially P. This is in accordance with the opinion of (Satria et al. 2015) that available P stimulate roots to absorb nutrients better so that plants can use it for the formation of new tissues, including increasing stem diameter. The increased

Table 3. The effect of type and dose level of foliar application on plant height, stem diameter and number of branches of butterfly pea (*Clitoria ternatea*)

Treatment	Parameter		
	Plant height (cm)	Stem diameter (cm)	Number of branches
Type of fertilizer			
Liquid organik fertilizer of rabbit	127.88±25.15[a]	1.07±0.05[a]	16.68±3.51[a]
Gandasil D fertilizer	139.95±25.00 [a]	1.09±0.07[a]	16.02±2.68[a]
Dose level			
0 g/l/plot	117.36±17.73[a]	1.04±0.03[a]	13.17±1.33[a]
1.5 g/l/plot	122.74±23.40[a]	1.06±0.05[a]	16.37±2.32[b]
3.0 g/l/plot	135.54±25.64[ab]	1.08±0.05[a]	16.92±2.25[b]
4.5 g/l/plot	160.02±11.12[b]	1.14±0.05[b]	18.96±3.25[b]
P Value			
Type of fertilizer	0.18	0.26	0.54
Dose level	0.01	0.01	0.01
Interaction	(-)	(-)	(-)

[a,b]Different superscripts in the same column showed significant differences (P<0,05).

diameter of the plant indicates that the plant is growing well. One of the external factors that affect plant growth is nutrition which includes water, minerals and nutrients available in the environment (Qibtyah 2015).

Number of branches

Result of the analysis showed that the type of fertilizer did not significantly affect number of branches (P> 0,05), but the dose level of foliar fertilizer significantly affected (P< 0,05) number of branches. The treatment of 1,5, 3 and 4,5 g/l/plot weren't significantly different (P> 0,05) but all three were significantly different from the treatment of 0 g/l/plot. The average number of branches due to treatment ranged from 16,37 to 18,96. Results obtained are in accordance with the research of (Arnawa et al. 2017) that the butterfly pea given bio-slurry fertilizer and a predetermined moisture content resulted the number of branches between 13,38 – 16,31.

The number of branches has a close correlation with plant height. This is because the higher the butterfly pea, the higher the number of branches so it increase the number of leaves of the plant. This is in accordance with the opinion of (Sutopo 2019) that every formation of many branches on a plant is always followed by a large number of leaves formed. This will affect the fresh production of the butterfly pea. Another factor that causes the number of branches obtained in the study to be classified as high, is the cutting of plants during the first harvest. Cutting the plant causes the auxin hormone to accumulate so that the cytokinin hormone to increase and has an impact on the growth of new shoots/branches. (Hariyadi et al. 2011), argues that cutting the main stem of the Jatropha curcas plant increase the number of branches higher than without cutting.

Leaf area

Effect of giving the type and dose of foliar fertilizers on the leaf area of the plant is presented in Table 3. The leaf area resulted was not significantly different in all treatments, both the leaves on the bottom, middle and top of the plant (P> 0,05). An increase in the level of the dose given has not been able to increase the surface area of the leaf. This could be due to the fact that the level of N contained was not sufficient to meet the needs of the plant. The N functions to form leaf green subtances or chlorophyll which plays a very important role in the process of photosynthesis. Adil et al. (2006) stated that the higher the level of N given (up to maximum limit) will increase the amount of chlorophyll in plants. The increased amount of chlorophyll caused the rate of photosynthesis to increase, so that plants grew optimally (Pramitasari et al. 2016). Another opinion that giving different dose had no effect on leaf area, presumably because the nutrient needs of plants had been fulfilled from the soil (Puspita et al. 2017).

Leaf area had close relationship with plant production. Result showed that leaf area in all treatments had the same average, even though fresh production had different results. This result

Table 4. Leaf area (cm^2) of butterfly pea with treatment of type and dose level of foliar fertilizers.

Type of fertilizer	Dose level				Average
	0 g/l/plot	1.5 g/l/plot	3.0 g/l/plot	4.5 g/l/plot	
Bottom					
A1	660	6.40	6.73	6.58	6.57±0.33[a]
A2	5.78	5.98	6.01	5.73	5.87±0.33[a]
Average	6.19±0.52[a]	6.19±0.40[a]	6.37±0.44[a]	6.15±0.64[a]	
Middle					
A1	15.11	14.78	14.90	15.15	14.98±0.87[a]
A2	15.53	15.40	15.29	16.34	15.64±0.98[a]
Average	15.32±1.3[a]	15.09±0.84[a]	15.10±0.7[a]	15.75±1.0[a]	
Top					
A1	13.12	12.33	13.83	15.43	13.67±2.62[a]
A2	12.44	14.16	13.94	15.61	14.04±2.10[a]
Average	12.78±2.2[a]	13.25±1.7[a]	13.88±3.2[a]	15.52±1.2[a]	

[a,b] Different superscripts in the same column and row showed significant differences (P< 0.05); A1 = liquid organic fertilizer of rabbit; A2 = gandasil D fertilizer

Table 5. The effect of application of type and dose level of foliar fertilizer on fresh and dry matter prodution of butterfly pea

Treatment	Forage production			
	Fresh (kg/plot)	Fresh (ton/ha)	Dry matter (kg/plot)	Dry matter (ton/ha)
Type of fertilizer				
Liquid organic fertilizer of rabbit	0.56±0.08[a]	15.49±2.39[a]	0.49±0.08[a]	13.70±2.09[a]
Gandasil D	0.64±0.15[a]	17.75±4.36[a]	0.56±013[a]	15.71±3.65[a]
Dose level				
0 g/l/plot	0.49±0.11[a]	13.63±3.00[a]	0.44±0.09[a]	12.21±2.45[a]
1.5 g/l/plot	0.61±0.15[ab]	17.03±4.05[ab]	0.54±0.13[ab]	15.13±3.46[ab]
3.0 g/l/plot	0.60±0.10[ab]	16.59±2.89[ab]	0.53±0.11[ab]	14.73±2.98[ab]
4.5 g/l/plot	0.69±0.10[b]	19.22±2.77[b]	0.60±0.07[b]	16.75±2.05[b]
P value				
Type of fertilizer	0.09	0.09	0.08	0.08
Dose level	0.04	0.04	0.05	0.05
Interaction	(-)	(-)	(-)	(-)

[a,b] Different superscripts in the same column and row showed significant differences (P< 0,05)

indicating that the plant had the same ability in terms of photosynthesis. Leaf area in a plant is very important in the process of photosynthesis. The wider the leaf surface, the better the photosynthesis process because the plant is able to absorb light optimally. (Saragih 2019) added that an increase in leaf area will result in greater assimilation. The ability of leaves to absorb sunlight can decrease if the process of leaf expansion is hampered (Maisura et al. 2015).

Fresh production

Type of fertilizer didn't significantly affect fresh production of butterfly pea (P> 0,05) while the fertilizer dose did significantly affect (P< 0,05) the production. Results of the analysis showed that a dose 4,5 g/l/plot was not significantly different from the treatment at doses of 1,5 and 3 g/l/plot (P> 0,05) but was significantly different from the treatment at 0 g/l/plot (P

< 0,05) while between treatments the dose levels of 0, 1,5 and 3 g/l/plot were not significantly different. This is presumably because the dose level used is still relatively low, affects the number of nutrients received by the plant.

Average production of butterfly pea flower due to treatment ranged from 0,60-0,69 kg/plot. The higher the fresh weight of the plant, the higher the fresh production. Table 4 also shows that the fresh production of butterfly pea in an area of one hectare due to fertilization treatment got better results than without fertilization, the results ranged from 16,59 to 19,22 tons. The fresh production obtained is higher than that of (Wafi et al. 2020) where the fresh production ranged from 3,7 to 7,25 tons/ha. The fresh production obtained can be influenced by internal factors and external factors. Internal factors include plant physiological conditions while external factors include environmental conditions and the surrounding climate and between these two factors climatic factors most influence production results. According to (Sariffudin et al. 2018) that among climatic factors such as rainfall, duration of sunlight, air humidity and temperature, rainfall is the most dominant factor affecting crop production.

Dry matter production

Dry matter content was obtained from 100 minus the water content (in %). The water content of this plant ranged from 9,94 to 14,09%. The treatment did not significantly affect dry matter production (P> 0,05) while the fertilizer dose did significantly affect (P< 0,05) the production. Results of the analysis showed that the treatment at dose of 4,5 g/l/plot wasn't significantly different from the 1,5 and 3 g/l/plot (P> 0,05), but was significantly different from the treatment at 0 g/l/plot (P < 0.05) while between the treatments of 0, 1,5 and 3 g/l/plot were not significantly different. Dry matter production obtained from the treatment ranged from 14,73-16,75 tons/ha. The results obtained are higher than that of (Jelantik et al. 2019) that dry matter production of *Clitoria ternatea* ranged from 5,18-7.81 tons/ha, but lower than that of (Sutedi 2013) where the dry matter production was 25-38 tons DM/ha. The dry matter production which was relatively the same in all treatments at the dose levels of foliar fertilizer was probably because the levels of N content in the liquid fertilizer was not too high so that the requirement of butterfly pea for N elements was not fulfilled.

The lack of existing nutrient content will have an impact on the inhibition of plant growth and development so that it affect the dry matter content of a butterfly pea plant. This is in accordance with opinion(Keraf et al. 2015), that the higher the dose of N fertilizer applied, the higher the dry matter production of kume grass. The element of N functions to compose plant chlorophyll, so that a lack of this element causes the photosynthesis process to be slightly hampered. (Koten et al. 2012) states that the age of harvesting affect the dry matter production of plant, this is because the longer the harvesting time, the longer the opportunity for plants to photosynthesize, resulting in accumulation of photosynthetic material in their plant tissues. The results of photosynthesis which are often called photosynthate will be used by plants to trigger plant growth so that the dry matter production also increases. (Saragih 2019) stated that if the leaf area increased, the assimilate produced would be greater as a result of the increased dry weight of the plant.

CONCLUSION

It is concluded that the type of foliar fertilizer had no significant effect on the morphological characteristics and production of the butterfly pea plant, while the dose level of foliar fertilizer had a significant effect on several morphological characteristic and production. The higher the dose of foliar fertilizer given the better the plant morphology, the higher fresh and dry matter production of butterfly pea. There was no interaction between the type and the dose level of foliar fertilizers on the morphology and production. With the right dose, liquid organic fertilizer of rabbits and gandasil D fertilizer can be used to increase production of *Clitoria ternatea*.

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Production Efficiency of Poultry Small-Scale Laying Hen in Indonesia

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ABSTRAK

Ilham N, Maulana M, Gunawan E. 2021. Efisiensi produksi peternak ayam ras petelur skala kecil di Indonesia. JITV 26(4):187-194. DOI: http://dx.doi.org/14334/jitv.v26i4.2967.

Daya saing usaha ayam ras petelur ditentukan oleh tingkat efisiensi, yang antara lain dipengaruhi oleh: tingkat adopsi teknologi, biaya produksi, dan skala ekonomi. Penelitian ini bertujuan untuk menganalisis kinerja usaha ayam ras petelur skala kecil. Lokasi penelitian ditetapkan pada daerah sentra produksi ayam petelur, yaitu Kota Payakumbuh di Sumatera Barat, Kabupaten Blitar di Jawa Timur, dan Kabupaten Sidrap di Sulawesi Selatan. Pengumpulan data dilakukan dari bulan April sampai Juli 2017. Data primer dikumpulkan melalui wawancara kepada 50 orang peternak dan 12 poultry shop di semua lokasi penelitian. Analisis tingkat efisiensi menggunakan *software* DEA (*Data Envelopment Analysis*), dan kelayakan usaha menggunakan analisis finansial. Hasil penelitian menunjukkan bahwa: (1) berkembangnya teknologi budi daya ayam ras petelur belum direspon peternak dengan baik, sehingga tingkat produksi dan kematian ayam masih di bawah standar; (2) secara relatif, tingkat efisiensi usaha ayam petelur di Sidrap dan Payakumbuh lebih baik dengan nilai lebih mendekati satu dibandingkan dengan usaha ayam petelur di Blitar, dimana ketidakefisienan tersebut disebabkan penggunaan input yang berlebih; dan (3) usaha ayam ras petelur skala kecil layak secara finansial, dimana faktor yang menentukannya adalah harga pakan dan harga telur. Rekomendasi kebijakan yang perlu diambil adalah penambahan tenaga pendamping peternak baik dari tenaga *technical service* perusahaan *poultry shop* maupun tenaga penyuluh pertanian. Biaya pakan harus diturunkan sebesar Rp1.000 di Blitar dan Rp57 di Sidrap per kilogram telur yang dihasilkan per siklus produksi. Selain itu, diperlukan alokasi bahan pakan yang baik untuk pelaku usaha di daerah, sehingga rasio harga pakan dan telur optimal.

Kata Kunci: *Data Envelopment Analysis* (DEA), Efisiensi, Ayam petelur

ABSTRACT

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Competitiveness of layer business was determined by the level of efficiency, which was influenced by the level of technology adoption, production costs, and economy of scale. This study was carried out from April to July aim to analyse the performance of small-scale layer poultry farming. The study site was in the layer production centre, namely in Payakumbuh West Sumatera, Blitar East Java and Sidrap South Sulawesi. Primary data were collected through interviews with 50 farmers and 12 poultry shops at all study sites. Analysis of the efficiency level is using DEA (Data Envelopment Analysis) software and business feasibility using financial analysis. The following were the main research findings: (1) the development of layer farming technology had not been responded well by farmers so that the production level and mortality of chickens were still below standard; (2) relatively, the level of layer poultry farming efficiency in Sidrap and Payakumbuh was better than in Blitar with a value closer to one, where the inefficiency was due to the use of excessive inputs; and (3) small-scale layer poultry farming was financially feasible, where the determining factors were feed and eggs price. The study recommended the need to add both technical service staff from poultry shops and local agricultural extension workers. Feed costs should be reduced by IDR 1,000 in Blitar and IDR 57 di Sidrap per kilogram of eggs produced per period. In addition, an accurate and better allocation of corn for feed was needed to optimise the ratio of feed and egg price optimal.

Key Words: Data Envelopment Analysis (DEA), Efficiency, Layer

INTRODUCTION

For a business to survive and reach a liable economy, the products must be competitively produced, and some efforts are carried out efficiently. Tangenjaya (2010) stated that efficiency is crucial for the poultry industry to achieve competitiveness affected by production costs, the economy of scale, business climate, vertical integration and the ability to adopt new technologies. Efficiency is greatly influenced by the size of input costs (Paly 2015). One way to improve cost efficiency is by vertical integration to increase value-added and economy of scale (Arli et al. 2012; Karthikeyan & Nedunchezhian (2013).

Production cost of laying hens is influenced by the number and price of production items used that consist

of feed, DOC or pullet, drug-vaccine-disinfectant (DVD), labour, and others (Paly 2015; Saliu et al. 2015; Muhamad & Rizal 2017). Feed is the highest production cost, reaching 71% of the total cost (Ramadhani 2018), 78% (Santoso et al. 2017), and 79% of total costs according to Ulfa et al. (2014). Meanwhile, egg production is not only influenced by the amount of feed consumption but also by age, health, genetics and its local environment (Ramadhan et al. 2018). In unfavourable environmental such as low health status and poor farm management status will increase feed ration conversion. At the same time, the number of eggs produced become lower (Utomo 2018), therefore, will get smaller efficiency.

Meanwhile, to determine input efficiency to produce outputs level or to achieve technical efficiency can be determined by using various methods such as the Cobb-Douglas production function (Yenibehit et al. 2019; Paly 2015; Muhamad & Rizal 2017), the frontier production function (Elpawati et al. 2018; Saliu et al. 2015; Fadwiwati et al. 2014) and Data Envelopment Analysis-DEA (Herawati 2015; Sari et al. 2014). The problem is that the first two methods are a stochastic quantitative approach. This approach practically has three weaknesses, namely: (1) it must meet several requirements before and after estimating; (2) the estimation results are related to statistical criteria, namely the significance of the relationship between the dependent and independent variables at a certain level; if the relationship is insignificant, it is not relevant for interpretation; and (3) difficult to apply to farms that have more than one outputs (Saliu et al. 2015; Paly 2015; Muhamad & Rizal 2017; Diyoga 1999). In contrast, DEA has advantages, including (1) measuring several outputs and inputs; (2) overcoming problem of small samples size; (3) different units and number of input and output variables; and (4) not necessarily require assumption as a functional relationship between variables (Herawati 2015; Cook et al. 2014).

Based on the advantages previously mentioned, the DEA method was applied to analyse production performance or technical efficiency of laying hens. This research was focused on-farm business, to analyse the production performance and profitability of small-scale layer chicken farming. These research findings will formulate policy analysis to develop a small-scale layer poultry industry.

MATERIALS AND METHODS

Study location

The study site was located in three provinces of layer production centre in Indonesia, Payakumbuh city in West Sumatera, Blitar regency in East Java, and Sidrap regency in South Sulawesi. This study use stratified of laying population, so the production centers divided into three classes: high class with population above 15 million, middle class 10-15 million, and the lower class 5-10 million. Data on layer population refers to the Animal Husbandry Statistics Book (Ditjen PKH 2016).

Data sources

The data were collected during the period of April – July 2017. Primary data was collected through interview with respondents of 50 farmers, 12 poultry shop owners and 9 commitee members of farmer groups in 3 location using structured questionnaire, while secondary data were collected from various related agencies as well as from internet.

Data analysis

Production efficiency will be calculated using Data Envelopment Analysis (DEA) method as measuring an efficiency calculation technique based on linear programming, which is used to calculate the relative performance efficiency of various businesses (Coelli 1996; Emrouznejad & Cabanda 2015). This method was used to measure the relative efficiency level of layer poultry of all types of farms in each location.

Relative efficiency was measured by constructing hypotheses, which locations were most efficient from various farm in the research areas through assigning an average weight for each input in each farm unit. Relative efficiency levels of each layer farming can be calculated and compared by assigning weights to each input and output, and its total weighted output then were divided by the total weighted inputs (Emrouznejad & Cabanda 2015), as presented in the formula (1).

$$j^{th} \text{ farm efficiency} = \frac{\sum_{r=1}^{n} OrYrj}{\sum_{i=1}^{m} ViXij} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where O_r is weight for output r, y_{rj} is number of output r for farm j, v_i is weight for input I, x_{ij} = number of inputs i for farm j n is number of outputs, m is number of inputs, and j is number of farms

In this study have four inputs and two outputs. The inputs used were: (x_1) feed cost (Rp / kg eggs / business cycle); (x_2) the number of hens (birds); (x_3) Drug-Vaccine-Disinfectant (DVD) cost per kg of eggs produced per cycle (Rp / kg eggs / cycle); (x_4) labor cost per kg of eggs produced in one business cycle (Rp / kg eggs / cycle). For outputs were: (y_1) chicken productivity (kg eggs / birds / cycle); (y_2) Egg production per farm (kg eggs / cycle).

The level of technical efficiency was calculated using the Variable Returns to Scale (VRS-TE) with input-oriented, where it is assumed that decision maker unit (DMU) is the farmer in a constrained state. To determine the weight of each input and output for each effort to achieve the efficiency target for each business, it is done through problem solving as used by Cook et al. (2014) and Anggela (2012) as follows:

$$(e_j) = \frac{\sum_{r=1}^{n} OrYrj}{\sum_{i=1}^{m} ViXij} \text{.....(2)}$$

subject to $= \frac{\sum_{r=1}^{n} OrYrj}{\sum_{i=1}^{m} ViXij} \leq 1$, for each farm (j)

o_r and $v_i \geq 0$

where e_j is max. efficiency $f_{j \text{ and}}$ e_j is j^{th} farm efficiency.

Maximum efficiency of j^{th} farm (e_j), with efficiency constraint of the whole farm was less than one. Variables *O* and *V* were weighted, and the solution to these problems was the best weighting values for each farm to produce a good relative efficiency level (e_j value). If $e_j = 1$, then a farm (for example farm 1) was relatively efficient against another. But if e_j was less than one, then one or several other farms were more efficient than farm 1(Cook et al. 2014; Anggela 2012).

DEA model was a linear programming based (Coelli 1996; Emrouznejad & Cabanda 2015), therefore the objective function has to meet the most important ratio between outputs and inputs, not the nominal of each variable and its weight. Therefore, to achieve the same effect the denominator (inputs) in the ratio was made as a constant and maximize the numerator (outputs). This condition results in input-oriented optimization, where the objective function is to maximize the output weight. The results of this optimization recommend as excess use of inputs in achieving output (Anggela 2012). In the form of linear programming, the above (Max. h_0) problems can be changed to:

$$\sum_r OrYrj \text{ .....(3)}$$

subject to $\sum_i VrXij = 100$ (determined)

$$\sum_r OrYrj - \sum_i VrXij \leq 0$$

Data processing was performed using DEA software and has been had been used by Prasetyo (2008) and Sari et al. (2014) in determining supply chain efficiency, and Heidari et al. (2011) in determining the efficiency of broiler farm in Brazil.

Financial analysis was used to find out the performance of layer poultry farming. The information required were: (i) types of inputs and production costs, (ii) type and value of investment, (iii) level of production, and (iv) type and value of revenue. Based on these data, cost of production and revenue per kilogram of eggs produced can be calculated, along with its R/C ratio and farm profit.

RESULTS AND DISCUSSION

Performance of production

According to Sharma et al. (2020), layer performance can be seen from hen day egg production (%), mortality (%), and other factors, namely egg weight, feed intake and feed conversion ratio. Production level of layer is the average percentage of chickens that lay eggs during one cycle. This data was ob

tained from the results of interviews during the survey and recalled data that had happened before. This is determined by the percentage at peak production, and how long the peak production take place. In overall, the average of production level during one production cycle reached 65% (Payakumbuh 68%, Blitar 63%, and Sidrap 64%). These figures were still below the standard issued by Hy-Line Brown, which was 83% (Hy-line International, 2014). Production level in more detail can be seen in Figure 1.

Relatively low egg production in Blitar was caused by higher temperatures in the area compared to the other two locations or regions. This condition was obtained from the results of observations during a survey with an indication of odor, and dry feces in the cage. Heat stress in poultry (above a comfortable temperature of poultry) would cause an increase in body temperature, thereby increasing drinking water consumption and decreasing feed consumption (Tamzil 2014; Kilic & Simsek 2013).

Mortality rate also determines farm performance. This data was obtained from the results of interviews by calculated the number of chickens that died from DOC to sold after non-productive divided by the number of DOC chick-in; or the number of chickens that died from the pullet to sold after non-productive divided by the number of pullets chick-in. The highest mortality rate occurred in Sidrap (13%). %). According to poultry shop owners most farmers still practice traditional system in raising DOC, therefore, a better use of new techniques, especially in raising DOC was needed, beside more intensive maintenance for chicken raising (Table 1). Farmers often ignored DOC housing preparation before chick-in and the time during brooding period. This finding was confirmed by the study of Bethel et al. (2016) in Nigeria, namely in order to increase productivity, the government should intensify farmers' visits and encourage farmers to become active member of local farmer association.

Technical efficiency

To assess the technical efficiency of layer at the study sites, a variable cost of feed per kg of eggs produced per cycle (Rp/kg of eggs/cycle), the number of laying hens raised (birds), DVD costs per kg of eggs produced per cycle (Rp/kg eggs/cycle), labor costs per kg of eggs produced in one cycle (Rp/kg eggs/cycle) were applied. Results analysis by using input-oriented DEA application as reflected by efficient use of inputs, can be seen in Table 2.

The level of technical efficiency was calculated using Variable Returns to Scale (VRS-TE) model which assumed that the Decision Making Unit (DMU) of farmers was constrained. The average VRSTE value of layer farming was 0.95. Based on location, in Blitar, Payakumbuh and Sidrap, the value of VRSTE were 0.88; 0.99; and 0.99, respectively. Technically Sidrap and Payakumbuh had almost the same level of efficiency and more efficient than Blitar. Likewise, the efficient population of farmers in Sidrap, Payakumbuh and Blitar were 64.7%; 57.1% and 6.3% respectively.

Inefficiency source of small-scale layer farm in Blitar was excessive use of all inputs. One example was the use of drug-vaccine-disinfectant (DVD) with slack value of 21.73. This was because farmers tend to apply drug-vaccine-disinfectant and vitamins to avoid risk (Ilham & Iqbal 2011). Moreover, the fact that the farm cycle of layer is relatively long, negligence in controlling and preventing disease can be fatal. Technically, Paly (2015) stated that inefficiency in the use of inputs caused by production and productive capacities that had decreased will not be efficient again even though the amount of input remains as before it experienced inefficiency. In other words, if the production curve had decreased, the increase in input given will not increase production.

The Cobb-Douglas log transformation function (Yenibehit et al. 2019), uses the number of birds, medication, the quantity of water, feeding, and the number of employees as input and the number of eggs produced over the production period as the only output. The results showed that the number of birds, medication, and water intake positively and significantly affected egg production. However, it only revealed the effect of independent variables increase and decrease TE, not the TE value.

The estimation with Stochastic Frontier Production Function (SFPF) (Elpawati et al. 2018) provides better outcomes compared to the Cobb-Douglas log transformation function. In addition to the variables affecting production, there is also information on TE value (i.e., 0.8858) and input slacks in poultry egg production. While the DEA model results indicate the excess per unit input, the SFPF model shows the percentage of inputs currently used. This study revealed that 90% of feed and 40% of labor inputs in the production layer are over-utilized.

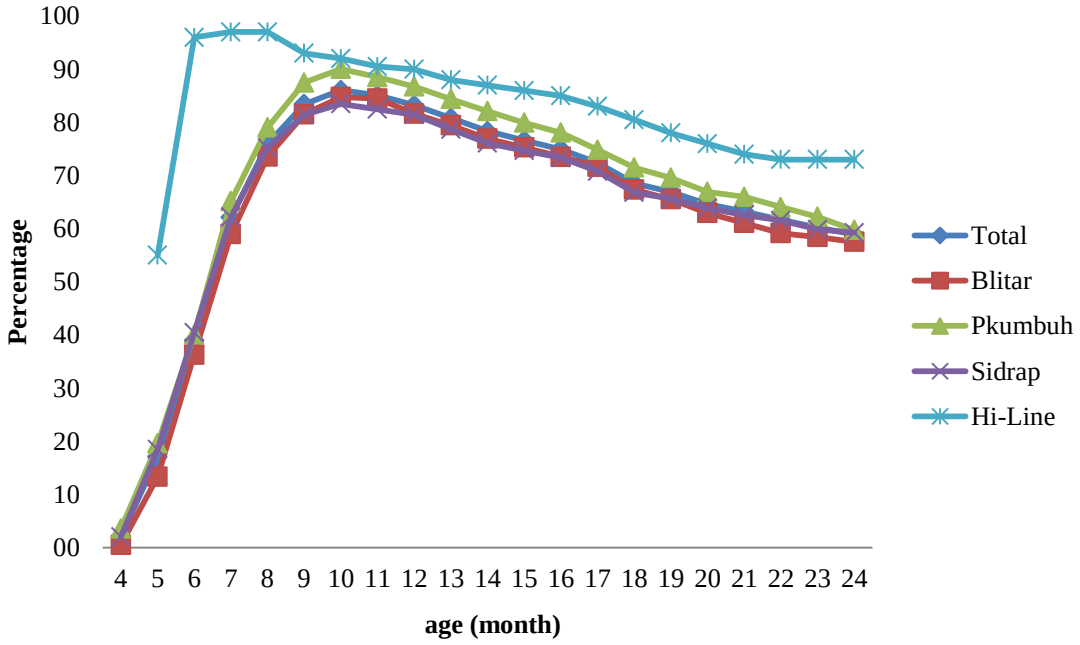

Figure 1. Percentage of chickens that lay eggs during one cycle at study site in 2017 from Primary Data, processed and Hy-line International (2014)

Table 1. Average ownership of pullet and mortality rates of pullet in the study site in 2017

No	Location	Pullet ownership (birds/farmer)	Dead Pullet (birds/cycle)	% Mortality
1	Total	2,964	237	8.00
2	Blitar	2,459	156	6.35
3	Payakumbuh	4,518	291	6.44
4	Sidrap	1,976	263	13.29

Source: Primary data (processed)

Table 2. Technical efficiency of layer farming at the study sites in 2017

Location	VRSTE value					Slacks Input*			
	1		**< 1**		average				
	Number of farmer	%	Number of farmer	%		Feed (Rp/kg egg/cycle)	Laying hens (birds/ cycle)	DVD (Rp/kg egg/cycle)	TK (Rp/kg egg/cycle)
Blitar	1	6.3	15	93.7	0.881	1,000.98	7.44	21.73	26.97
Paya- kumbuh	8	57.1	6	42.9	0.985	0.00	0.00	0.00	15.77
Sidrap	11	64.7	6	35.3	0.986	57.44	0.00	0.00	0.00
Total	20	42.6	27	57.4	0.950	361.54	2.53	7.40	13.88

Source: Primary Data (processed)
* DVD=drugs, vaccines and disinfectant; TK=labor

Table 3. Cost, revenue and profit of layer farming in the study sites, 2017

No	Description	Blitar	Payakumbuh	Sidrap
I	Cost (Rp/kg egg/cycle)	15,659	14,332	15,014
1	Pullet	1,886	1,850	1,889
2	Feed	12,852	11,611	12,010
3	Drug-vaccine-disinfectant (DVD)	296	285	225
4	Operational	98	14	14
5	Labor	223	219	291
6	Depreciation	304	289	236
7	Packaging	0	50	320
8	Transport	0	14	29
II	Egg Production (kg/cycle)	89,786	178,712	64,084
III	Revenue (Rp/kg egg/cycle)	16,874	18,707	17,734
1	Egg Selling	15,960	17,440	16,533
2	Old pullet	897	1,155	1,077
3	Manure	17	112	124
IV	Profit (Rp/kg egg/cycle)			
1	Egg	301	3,108	1,519
2	Egg & Old pullet	1,198	4,263	2,596
3	Egg, Old pullet & manure	1,215	4,375	2,720
4	R/C Egg	1.02	1.22	1.10
5	R/C Egg & old pullet	1.08	1.30	1.17
6	R/C Egg, Old pullet & manure	1.08	1.31	1.18

Source: Primary Data (processed)

Farm business

The performance of layerr farming can be seen from the profits. The analysis of layer farming in this study area shows in Table 3. Farm profits are not only determined by productivity as a condition of necessity, but also the balance of input prices that determine production costs and output prices which determine the amount of revenue. In this study, layer farm generate revenue from eggs selling, old laying hens selling and manure selling.

Layer farming in Payakumbuh showed better profit than Sidrap and Blitar. In fact, besides farm scale (Table 3) and technical efficiency (Table 4), the price of rice bran in Payakumbuh was relatively cheaper, thus the price of feed was also lower, compared to the two other regions. In addition, egg prices were relatively higher compared to other regions. Details can be seen in Table 5. These findings were better than Nawawi et al. (2017) in Majalengka West Java, which found that generally the R/C ratio of layer farms was 1.07.

In Payakumbuh and Sidrap, chicken feces can be used as organic fertilizer and as a byproduct of layer farm that provided better economic value than in Blitar. The same thing was also found in other layer farming (Santoso et al. 2017; Abadi et al. 2017). Byproducts of poultry industry that can be processed for a better use and managed with good techniques will reduce environmental pollution and provide an economic value (Mishra et al. 2015).

CONCLUSION

The development of layer breeding technologies had not been responded well by farmers in the studied locations. Traditional or old method in raising layers was still practiced and often ignore, especially the preparation of DOC housing before chick-in and the accuracy period during brooding. As a result,

production levels were still below standard and mortality rates were still high. In relative terms, the level of technical efficiency of layer in Sidrap and Payakumbuh was better with VRSTE values 0.99 compared to Blitar (0.88). Inefficiency in Blitar was caused by excessive cost of feed and labor inputs. Small scale layer farming was financially feasible in the three locations. Layer farms in Payakumbuh were relatively more profitable. This was partly due to greater farm scale, lower feed prices, and more expensive eggs price than in the other two locations.

Utilization of manure (feces) for organic fertilizer was able to reduce environmental pollution and also provided income, as well as improved farm efficiency and sustainability. Various supports were still needed from both poultry shops (Technical Service) and Extension Workers to make farmers to practice better layer technology. Feed costs should be reduced by IDR 1,000 in Blitar and IDR 57 per kilogram of eggs produced per production cycle. Distribution system of maize and rice bran as the main raw material for small-scale layer poultry farming need better government attention, in order to optimize the ratio of feed and egg prices.

ACKNOWLEDGEMENT

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UDC: 637.5'62

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Pencitraan ultrasonografi untuk pendugaan kualitas karkas pada Sapi Pasundan berdasar nilai kondisi tubuh (Ultrasound imaging to estimate carcass quality of Pasundan cattle based on body condition score)

(Org: Eng)

JITV 26(1): 1-9

This research aimed to estimate carcass quality of Pasundan cattle using ultrasound imaging based on Body Condition Score (BCS). Total 31 head of female cattle with age ranging from 4 to 7 years from Regional Technical Implementation Unit of the Center for Artificial Insemination and Artificial Insemination for Beef Cattle Development at Ciamis West Java, Indonesia with BCS ranging from 1.0-4.0. The marbling score, intramuscular fat (IMF), backfat thickness (LP), and thickness musculus of m. longissimus dorsi (LD), m. psoas major (PM), m. psoas minor (PMN), m. gluteus medius (GM) and m. biceps femoris (BF) were scanned using ultrasound on 3 different locations, i.e. on 12^{th}-13^{th} ribs (thorax), lumbar 4^{th} - 5^{th} (lumbar), and between tuber coxae and tuber ischii (gluteal) with 5 MHz frequency of convex transducer. The results showed that BCS increased when LP, marbling score and IMF from m. LD, m. PM, m. PMN, and m. GM was rising. Pasundan cattle showed marbling scores ranging from score 1 to 5 and percentage IMF ranging from 2.62% to 4.82%. Body Condition Score affected carcass quality of Pasundan cattle on parameters such as musculus thickness, marbling score, and intramuscular fat (IMF) from ultrasound imaging of m. LD, m. PM. m. PMN, m. GM, and m. BF.

(Author)

Key Words: BCS, Carcass, Pasundan cattle, Ultrasound.

UDC: 631.466

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Profil molekuler *Trichophyton mentagrophytes* dan *Microsporum canis* berdasarkan PCR-RFLP dari *internal transcribed spacer* (Molecular profile of *Trichophyton mentagrophytes* and *Microsporum canis* based on PCR-RFLP of internal transcribed spacer)

(Org: Eng)

JITV 26(1):10-21

Trichophyton mentagrophytes and *Microsporum canis* are dermatophytes fungi which commonly infect animal and human. Conventional and molecular methods were used for identification of the fungus. The region of internal transcribed spacer (ITS) has a high probability for fungal identification. PCR-RFLP was reported as a useful method to differentiate dermatophytes fungi. The objective of the study was to compare molecular profile of *T. mentagrophytes* and *M. canis* based on the result of ITS fragment digestion using Dde I, Hinf I and Mva I. The molds were isolated from skin scrapping of 18 animals which showed dermatophytosis lesion. The isolated molds were grown on agar plate for 14 days of incubation at 37^{o}C and then identified based on macro and microscopic morphologies. Amplification of chitin synthase gene was used for confirmation and separation of dermatophytes from other fungi. ITS fragment was amplified and then digested using restriction enzymes Dde I, Hinf I and Mva I. The result showed that digestion products from ITS fragment of *T. mentagrophytes* and *M. canis* were different. The fragment 159 bp from Dde I, 374 bp from Hinf I and 89 bp from Mva I were present in *T. mentagrophytes* but absent in *M. canis*. Based on these results, specific RFLP profile of digestion ITS region by Dde I, Hinf I and Mva I can be used as a specific marker for species of dermatophytes fungi.

(Author)

Key Words: Dermatophytes, Internal transcribed spacer, PCR RFLP

UDC: 616-092

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Patogenitas isolat *Trypanosoma evansi* asal Philippina dan Indonesia pada mencit serta responnya terhadap trypanosidal (Pathogenicity of Philippine and Indonesian *Trypanosoma evansi* isolates in mice and their responses to trypanocides)

(Org: Eng)

JITV 26(1): 22-30

Pathogenicity of 10 isolates of *T. evansi* collected from Mindanao, Philippines, and one isolate from East Java, Indonesia was determined and compared. The susceptibility of these isolates against diminazene aceturate, melarsomine dihydrochloride, suramin and quinapyramine sulphate/chloride was also tested. Twenty-five mice were infected intraperitoneally with each isolate and 20 were

treated with the 4 drugs (5 mice/drug) while 5 infected and 7 uninfected mice served as infected-untreated and uninfected controls, respectively. Treatment was carried out 24 hours post-infection and parasitemia was monitored for 35 days. Mice infected with Philippine isolates significantly died earlier (5-11 days) than those infected with the Indonesian isolate (14-16 days). The prepatent period for Philippine isolates (3-8 days) was significantly shorter than the Indonesian strain (11-13 days). Trypanosomes were not observed in the blood of mice infected with any of the Philippine isolates when treated with quinapyramine sulphate/chloride, melarsomine dihydrochloride or suramin. Two of 10 mice infected with either C4 or A9 Philippine isolates and treated with diminazene aceturate had parasitemia on days 29 and 31, respectively. It is concluded that isolates of *T. evansi* from Mindanao, Philippines, are more pathogenic than the isolate from East Java, Indonesia. This study also indicated that quinapyramine sulphate/chloride, melarsomine dihydrochloride and suramin are effective against these *T. evansi* isolates from Mindanao, Philippines and East Java, Indonesia, while two of the Mindanao isolates are resistant to diminazene. This information is valuable in the enhancement of the control strategy against surra in the Philippines and Indonesia..

(Author)

Key Words: East Java, Mindanao, Pathogenicity, Resistance, *Trypanosoma evansi*

UDC: 599.323.4

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Peran imunomodulator *Virgin Coconut Oil* pada Tikus Wistar yang diinfeksi dengan *Staphylococcus aureus* (Immunomodulatory effects of virgin coconut oil in wistar rats infected with *Staphylococcus aureus*)

(Org: Eng)

JITV 26(1): 31-38

Virgin coconut oil (VCO) contains bioactive that induce immunity against infectious diseases. This study aim to determine the immunomodulatory effects of VCO based on the activity of superoxide dismutase (SOD), lymphocyte proliferation, and histopathological examination in liver and kidney of rats infected with *Staphylococcus aureus*. The VCO was given intragastrically to rats with a dose of 250 µL for one week. The rats were infected with *S. aureus* at $5x10^2$ bacterial cells intraperitoneally. Twenty (20) female *Wistar* rats of one month old were divided into four groups. The negative control group (C-): without treatment, AV group: infected with *S. aureus* followed by VCO treatment; VA group: pretreated with VCO followed by *S. aureus* infection, and positive control group (C+): were infected with *S. aureus* without VCO. All rats were euthanized and necropsied based on the animal ethic standard. Plasma samples were taken to evaluate SOD activity, and lymphocytes were isolated from the spleen to determine their proliferative ability. Livers and kidneys were collected for a histopathology examination. Results showed that the VA group had the highest SOD activity on the 4^{th} week (41.50 ± 3.56 %) and lymphocyte proliferation (0.3018) compared to all treatments, indicating immunomodulatory effects of VCO. Liver of treatments group showed leucocytes infiltration, no hemorrhages (VA); the hepatocytes with normal cells (VA). Kidney of treatments group showed leucocytes infiltration (AV); normal epithelial glomerulus and tubulus cells, still found hemorrhage (VA). These studies indicated that VCO has a potential role as an immunomodulator, hepatoprotectant, and nephroprotectant.

(Author)

Key Words: Virgin coconut oil, *Staphylococcus aureus*, Superoxide dismutase, Lymphocyte proliferation, Liver, Kidney

UDC: 637.54'65

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Pengaruh pakan tepung bonggol-pisang-modifikasi (TBP-M) sebagai bahan pengganti jagung pada kinerja pertumbuhan, karakter karkas dan daya cerna pakan itik hibrida (Peking x Khaki Campbell) [(Effect of dietary modified-banana-tuber meal (M-BTM) substituting corn on growth performance, carcass traits and dietary-nutrients digestibility of coloured-feather hybrid duck (Pekin x Khaki Cambell))

(Org: Eng)

JITV 26(1): 39-48

In this experiment, we investigate the effect of modified banana tuber meal (M-BTM) to substitute dietary maize in growing-finisher colored-feathered hybrid duck. One hundred and ninety six hybrid ducks (Pekin x Khaki Campbell) with 421.31 ± 0.183g body weight (BW) were allotted to 5 dietary treatments with 9 ducks (unsexed) per pen and 4 replications per treatment. These dietary treatments were: NC (negative control; maize-soyabean-meal based diet), BTM25 (25% maize was replaced by M-BTM-), BTM50 (50% maize was replaced by M-BTM), BTM75 (75% maize was replaced by M-BTM), and BTM100 (100% maize was replaced by M-BTM). The experimental design applied using completely randomize design (CRD). Data of this experiment were statistically analysed by one-way-analysis-of-variance of SAS University version 4.0 red hat (64-bit) University Online Edition. Result demonstrated that M-BTM improved significantly ($p< 0.05$) digestibility of dry matter and crude protein. It is concluded that M-BTM enhanced apparently growth performaces and digestibility parameters of colored-feathered hybrid duck (Pekin x Khaki Campbell).

(Author)

Key Words: Carcass, Digestibility of energy, Hybrid ducks, Modified banana tuber meal

UDC: 637.5'62

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Asosiasi SNP g.232 G>T gen calpain dengan pertumbuhan dan prediksi kualitas daging hidup menggunakan citra ultrasonografi pada Sapi Bali (Association of SNP g.232 G>T calpain gene with growth and live meat quality prediction using ultrasound images in Bali Cattle)

(Org: Eng)

JITV 26(2): 49-56

Bali cattle (*Bos javanicus*) are native Indonesian cattle, domesticated from banteng (*Bibos banteng*). Genes that have an important role in meat quality are calcium-activated neutral protease genes, known as calpains (CAPN). The objective of this study was to evaluate the polymophisms of calpain gene SNP g.232 G>T by PCR-RFLP technique and its influence on growth trait and meat quality of Bali cattle detected by ultrasound imaging of *longissimus dorsi* thickness (LDT), back fat thickness (BFT), marbling score (MS), and intramuscular fat percentage (PIMF). The polymorphisms of CAPN1 gene were analyzed by PCR-RFLP using BglII restriction enzyme (n=52 cattle). The ultrasound images of longissimus dorsi muscle were carried out transversally and longitudinal between 12^{th} -13^{th} thoracic vertebrae then analyzed by Image-J NIH software. Result showed that SNP g.232 G>T of CAPN1 gene was polymorphic in Bali cattle. SNP g.232 G>T of CAPN1 gene in Bali cattle has higher diversity which was showed of 0.48 heterozygosity value and was in Hardy-Weinberg equilibrium. The polymorphisms of SNP g.232 G>T was associated significantly (P<0.05) with bodyweight at 730 days, marbling score (MS), and intramuscular fat percentage (PIMF). It suggests that the CAPN1 gene in Bali cattle is a candidate for Marker Assisted Selection (MAS), which influences body weight at 730 days, marbling score, and percentage of intramuscular fat.

(Author)

Key Words: Bali cattle, Calpain gene, Growth, Meat quality, Ultrasound

UDC: 599.735.51

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Metabolisme energi dan performans beberapa bangsa sapi lokal yang diberi pakan jerami padi dan konsentrat (Energy metabolism and performance of several local cattle breeds fed rice straw and concentrate)

(Org: Eng)

JITV 26(2): 58-64

This study was conducted to examine the effect of different local cattle breeds on energy metabolism and performance fed on rice straw basal diet. Fourty local male cattle (2.5 years; initial BW 300.30±0.68) of Madura cattle (M), Sumba Ongole cattle (SO), Bali cattle (B), and Bali Timor cattle (BT) were used in this study, where types of local breed were used as treatments (10 animals/treatment). The study used a randomized block design (RBD) with cattle's initial body weight as a group. The cattle were fed on rice straw ad libitum and concentrate 2.5% BW (DM 86.53%). The variables measured were energy intake (EI), digestible energy intake (DEI), metaboloizable energy intake (MEI), energy retention (RE), RE to EI ratio, RE to DEI ratio, C2/C3 ratio, the efficiency of hexose conversion to VFA (ECH) and the average daily body weight gain (ADG). The results showed that the different breeds of local cattle had a significant effect (P<0.05) on EI, DEI, MEI, RE, RE to EI ratio, RE to DEI ratio, C2/C3 ratio, and ECH, but had no significant effect on ADG (P>0.05). M has the highest EI, DEI, MEI, and RE 139.52 MJ/day, 99.69 MJ/day, 65.84 MJ/day, and 98.45 MJ/day, respectively, but the highest RE to EI ratio at B, while for the best RE to DE ratio, C2/C3 ratio, ECH, and ADG, at SO were 99.24%, 28.85, 74.97%, and 1.24 kg, respectively. It can be concluded that the best local cattle in terms of performance and feed energy efficiency are Sumba Ongole cattle.

(Author)

Key Words: Energy efficiency, Local cattle breeds, Metabolism energy, Rice straw

UDC: 613.287.5

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Aplikasi plantarisin sebagai substrat antimikroba dalam proses pemerahan untuk mempertahankan kualitas susu pada peternakan sapi perah rakyat (Application of plantaricin as an antimicrobial substrate in the milking process to maintain milk quality in smallholder dairy farm)

(Org: Eng)

JITV 26(2): 65-73

Pathogenic bacterial contamination found in fresh cow's milk can be caused by poor milking management. This traditional milking process allows the milk to be contaminated from bacteria and dirt. Dyeing dairy cows using a commercial antiseptic is a common measure that can be done to prevent mastitis. Nipple immersion can be done after milking using synthetic antiseptic agents such as povidone iodine and chlorine. However, the use of synthetic antiseptics can actually cause a slight irritation and allergic effect and leave a residue. Therefore, it is hoped that the use of natural-based antiseptics can replace synthetic antiseptics. One of the natural based antiseptics that can be used is bacteriocin. This research aimed to analyze the application of the plantaricin IIA-1A5 as a substitute for synthetic antibacterial for teat dipping before milking namely microbiological tests, physicochemical tests, and pH measurements. The study was conducted using a randomized block design (RBD) with three replications. The treatment design consisted of control (without immersion), plantaricin 0.0074%, and povidone iodine 0.2%. Results showed application of plantaricin IIA-1A5 as teat dipping before milking can reduce the Total Plate Count, *Escherichia coli*, and *Staphylococcus aureus* population. The use of plantaricin IIA-1A5 as teat dipping did not change pH value and physicochemical quality (fat, SNF, lactose, and protein), which is below the Indonesian National Standard (SNI) about fresh milk. This ability is comparable to the iodine group, a synthetic antibacterial widely used by smallholder breeders in Indonesia. It is concluded that plantaricin IIA-1A5 can be used as a substitute for synthetic antibacterial (iodine group) for teat dipping before milking.

(Author)

Key Words: Fresh milk, *L. Plantarum* IIA-1A5, Plantaricin IIA-1A5

UDC: 599.323.4

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Pengaruh tepung ekstrak tulang ayam terhadap kualitas sperma epididimal tikus Wistar jantan (Effect of chicken bone extract powder on epididymal sperm quality of male Wistar rats)

(Org: Eng)

JITV 26(2): 74-81

Calcium is one of the minerals that are essential for male reproductive function. Calcium deficiency adversely affects spermatogenesis, normal sperm function and results in infertility. The sperm quality of rats fed a standard diet containing chicken bone extract powder (BEP) was assessed in the present study. Twenty male 8-week-old rats, Wistar strain, were randomized by weight into two groups of ten rats each and fed ad libitum a standard diet containing calcium carbonate ($CaCO_3$, control) or chicken BEP; both were equivalent to 0.5% calcium. At the end of the 7-week consumption, the net body weight gains measured in control (101.33±21.81 g) and chicken BEP groups (100.74±26.80 g) were not significantly different (P>0.05). The *in vitro* sperm quality in terms of concentration, motility, viability, resistance to hypotonic stress, acrosomal reaction ability and morphology was comparable between control and chicken BEP (all were P>0.05). The results suggest that chicken BEP addition into feeds is an alternative calcium source that is as effective but less expensive as $CaCO_3$, a commercial calcium (fortificant). At least, it has no detrimental effect on male reproductive function.

(Author)

Key Words: Calcium, Chicken bone, Diet, Rat, Sperm

UDC: 575.113.1

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Identifikasi keragaman gen Avian Beta Defensin 2 (AvBD2) pada ayam IPB-D1 [(Avian Beta Defensin 2 (AvBD2) gene polymorphism identification in IPB-D1 chicken)]

(Org: Eng)

JITV 26(2): 82-89

Avian Beta Defensin 2 (AvBD2) gene, located in chromosome 3, plays an important role in the immune system of the chicken by inhibiting the development of microorganisms such as bacteria that infect body tissues. Defensins are produced through epithelial cells immediately after tissue injury or infection, which then processes the maturation of dendritic cells to initiate an immune response in the lymph nodes. The purpose of this study was to discover the polymorphism of the AvBD2 gene in IPB-D1 chickens. PCR and direct-DNA sequencing methods were used to identify the polymorphisms of intron 1, exon 2, and intron 2 AvDB2 genes in 47 chickens. Genotype and allele frequency, and heterozygosity calculations were carried out to obtain information of the AvBD2 gene polymorphism. A total of 10 single nucleotide polymorphisms were found in the AvBD2 gene located in intron 1 (g.4843T>A, g.4853G>A, and g.4859T>C), exon 2 (g.4881A>G, g.4889G>A, and g.5002C>T), and intron 2 (g.5075C>T, g.5111T>G, g.5116G>T, and g.5177G>T). All SNPs are polymorphic. The g.5002C>T mutation causes changes in the amino acid Ala to Val which has the potential to be a candidate for characterizing disease resistance in IPB-D1 chickens.

(Author)

Key Words: AvBD2 gene, IPB-D1 chicken, Polymorphism

UDC: 636.2.033

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Fluktuasi asimetris meningkat seiring dengan gangguan stres panas pada Sapi Bali *(Bos javanicus*) di ketinggian yang berbeda [(Fluctuating asymmetry increases with heat stress disruptions on Bali cattle *(Bos javanicus*) at different altitude)]

(Org: Eng)

JITV 26(3): 89-95

Bali cattle (*Bos javanicus*) are common species distributed throughout Indonesia to survive in tropical hot, and humid climates. Fluctuating asymmetry (FA) is a random deviation from perfect bilateral symmetry. FA is often used to measure developmental stability in individuals and can be used as a marker for the impact of environmental and genetic stress. This study aims to investigate the pattern of developmental instability in Bali cattle as caused by environmental stress at various altitudes using the FA index. FA indexes in this study were used to compare asymmetrical physical traits of Bali cattle in Sembalun high altitude and Serading low altitude. Sixty-five Bali cattle were used in this study reared at different altitudes, namely Serading, Sumbawa Island (50 m above sea level), and Sembalun, Lombok Island (1,186 m above sea level). The physical traits of Bali cattle measured were horn circumference (horn), a distance of hip to spine bone (pelvic), metatarsal circumference (metatarsal), and metacarpal circumference (metacarpal). The FA1 and FA5 indexes showed significant metacarpal differences between Bali cattle reared at Sembalun and Serading population (P<0.05). FA11 multiple trait index as a composite of all traits revealed a significant difference as well. (P<001). It can be concluded that various heat stress by altitude impacts the asymmetry of Bali cattle.

(Author)

Key Words: Altitude, Bali cattle, Fluctuating asymmetry, Heat stress

UDC: 636.084.41

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Proteksi bungkil kedelai menggunakan ekstrak daun mahoni pada ransum ruminansia: pengaruhnya terhadap produk fermentasi rumen (Protection of soybean meal using mahogany leaf extract in ruminant ration against rumen fermentation products)

(Org: Eng)

JITV 26(3): 96-107

The study was aimed to examine effect of protecting soybean meal using mahogany leaf extract on rumen fermentation products *in vitro*. The material used was cow rumen fluid, basal ration consisting of concentrate and elephant grass with a ratio of 60:40%, and mahogany leaves. The research was carried out in three stages: mahogany extraction, protein protection using mahogany extract, and *in vitro* stages. The test was conducted *in vitro* based on a completely randomized design (CRD). The treatments consisted of 4 kinds of soybean meal protection with 0% tannin concentration (T0); 1.5% (T1); 3% (T2); and 4.5% (T3). Data obtained were analyzed by analysis of variance and tested using orthogonal polynomials. Results showed that addition of protected soybean meal with mahogany leaf extract had a cubical effect on partial VFA, methane gas and post-rumen dissolved protein, a quadratic effect on protozoa, and a linear effect on N-NH_3, SPM, and RUDP. Giving extra mahogany leaves at a level of 1.5% produced a fermented product that was not different from the control while giving a level of 3% got the highest fermentation product. Giving mahogany leaf extract at a level of 4.5% resulted in the highest SPM, and RUDP but there was a decrease in soluble protein, which indicated the occurrence of overprotection. The addition of 3% mahogany leaf extract effectively increased rumen fermentation products, RUDP, and soluble protein without disturbing the activity of rumen bacteria.

(Author)

Key Words: Microbes, Protein, Rumen, Tannins

UDC: 636.082.4

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Karakteristik libido dan konsentrasi hormon testosteron sapi Bali jantan *polled* dan bertanduk setelah penyuntikan GnRH (Characteristics of libido and testosterone concentration of polled and horned Bali Bulls after GnRH injection)

(org: Eng)

JITV 26(3): 108-114

Bali cattle are one of the original Indonesian germplasm, which in its development were found to be hornless or polled. Polled are Balinese cattle whose horns do not grow naturally, but have the same characteristics as those with horns. However, there are indications that polled have a lower libido. The purpose of this study was to determine the characteristics of libido and testosterone concentration after gonadotrophin releasing hormone (GnRH) injection. In this study each of 7 male polled and horned Bali cattle aged 3.5-6 years were used. Libido characteristics were observed by recording the first time the male fondled the teaser until ejaculation, while the testosterone concentration was measured using blood plasma taken on day 0 or before injection, day 7^{th}, and day 14^{th} after GnRH injection. Testosterone analysis used enzyme linked immunosorbent assay (ELISA) method. The results showed that the libido of polled was not different ($P>0.05$) compared to that of the horned on the 0, 7^{th} and 14^{th} days after GnRH injection. However, in polled on the 7^{th} day after GnRH injection, it was significantly lower than on day 0 and 14, but on day 0 it was not different with day 14. Testosterone concentration on day 7 after injection of GnRH was not different ($P>0.05$) compared to day 0 both in polled and horned bulls, but on day 14 after injection was significantly higher ($P<0.05$) in horned than polled. In conclusion, polled and horned Bali bulls had high libido with a score of +1, but on the 7^{th} day after GnRH injection, polled had lower libido than horns. The testosterone concentrations of polled and horned on day 7 after GnRH injection were not different compared to day 0, while the 14^{th} day was higher in horned bull.

(Author)

Key Words: GnRH, Horned, Libido, Polled Bali Bulls, Testosterone

UDC: 57.083.24

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Resistensi amantadin terhadap virus avian influenza subtipe H5N1 clade 2.3.2 di Indonesia (Amantadine resistance of clade 2.3.2 H5N1 Avian Influenza virus from waterfowl in Indonesia)

(Org: Eng)

JITV 26(3): 115-123

The objective of this research was to know the sensitivity of H5N1 clade 2.3.2 AIV from Indonesia to antiviral drug (amantadine) through molecular and *in vitro* tests. The study was conducted by virus isolation and identification, nucleotide analysis, and susceptibility to the amantadine hydrocloride in MDCK cells. The study result represented that the mean EID_{50} isolates of H5N1 clade 2.3.2 AIV was determined of $>10^8$ EID_{50}/ml. The analysis of phylogenetic tree of M2 gene from six viruses of H5N1 clade 2.3.2 AIV from Indonesia were closed with H5N1 clade 2.3.2 AIV avian influenza viruses from Vietnam, China, Hongkong. The substitution of M2 protein (V27I) was identified in six isolates H5N1 clade 2.3.2 AIV isolated from Indonesia. Avian influenza of clade 2.3.2 H5N1 subtype from Indonesia produced the formation of CPE and the positive HA reaction with non-toxic concentration of amantadine hydrochloride in MDCK cells. The result of genetic analysis of M2 gene for amantadine resistance was related with the results of HA test and the formation of CPE in MDCK cells. These results established that amantadine resistance have been identified in H5N1 clade 2.3.2 AIV viruses isolated from Indonesia

(Author)

Key Words: Avian Influenza of clade 2.3.2, Waterfowl, Amantadine resistance, Indonesia

UDC: 636.082.4

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Pengaruh interaksi suplementasi vitamin e-selenium dan energi metabolis terhadap performa reproduksi induk Joper (Interaction effect of vitamin e-selenium supplementation and metabolic energy on reproductive performance of Joper Breeders)

(Org: Eng)

JITV 26(3): 124-131

The side effect of fatty acid oxidation during lippoprotein synthesis is the release of oxygen in the tissue called reactive oxygen species (ROS). Metabolic stress in Joper brooders due to an imbalance between ROS and antioxidants causes a decrease in hatching egg production and quality. Therefore, research is needed to improve the reproductive performance of Joper broodstock by combining vitamin E-selenium supplementation and metabolic energy. This study used 200 hatched eggs resulting from a cross between 60 weeks old Sentul males and 35 weeks old ISA BROWN laying hens that had been treated. This study used a Factorial Completely Randomized Design (CRD) (2 x 4). The first factor is the energy level (2700 and 2800 kcal/kg) and the second factor is the dose of vitamin E-selenium supplementation (0, 25, 50, 75 and 100 ppm). Selenium dosage is 1ppm/mg vitamin E. The interaction between vitamin E-selenium supplementation and energy had a very significant effect ($P<0.01$) in increasing DOC weight. The single factor energy level and vitamin E-selenium supplementation significantly ($p<0.05$) in reducing embryo mortality and increasing hatchability, while fertility and eggshell quality were not affected by the two treatment factors. The conclusion of this study is the interaction between vitamin E-selenium supplementation and energy levels can increase the weight of Joper's DOC, while the single factor of vitamin E-selenium supplementation and energy levels can reduce embryo mortality and increase hatchability. The best interaction with 100 ppm vitamin E-selenium supplementation and energy 2800 kcal/kg.

(Author)

Key Words: Feed supplements, lipoprotein and Joper breeders

UDC: 299.323.4

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Studi fungsi hati tikus neonates jantan untuk induk yang disertraline (Studying the liver function in male neonates of rats born to sertraline-treated mothers)

(Org: Eng)

JITV 26(3): 132-138

Sertraline is an antidepressant which has toxic effects on the liver. This study was conducted to evaluate the effect of Sertraline administration in pregnancy on liver function of male neonates of rats. Twenty-five pregnant female Wistar rats were divided into 4 groups of 5. The control group did not receive any drug treatments, but experimental (Exp) groups 1, 2 and 3 received 5, 10 and 20 mg/kg Sertraline as gavage throughout the pregnancy, respectively. Twenty-two days after birth, male rats were divided into 4 groups of 10 based on the previous division and after weighing, by taking blood directly from the heart, serum levels of Alanine transaminase (Alt), Aspartate transaminase (AST), Alkaline phosphatase (Alp), Albumin (Alb), Total protein (TP), and Bilirubin (Bili) were measured and the liver tissue was also analyzed histopathologically after weighing. In Exp groups, a significant decrease in body weight, TP and Alb serum levels were observed compared to the control group ($p<0.05$). In Exp group 3, a significant decrease in liver weight was observed compared to the control group ($p<0.05$). In Exp groups 2 and 3, a significant increase in serum levels of Alp, Alt and Bili in was observed compared to the control group ($p<0.05$). A significant increase in AST serum level was observed in Exp groups compared to the control group ($p<0.05$). Liver tissue destruction was observed in all 3 Exp groups. The administration of Sertraline in pregnant female rats causes liver damage and increases liver enzymes and blood biochemical parameters in their male offspring.

(Author)

Key Words: Albumin, Liver Development, Liver Enzymes, Rat, Sertraline

UDC: 613.286

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Karakterisasi nano kalsium laktat dari kerabang telur ayam yang disintesis melalui metode presipitasi sebagai bahan suplemen pangan (Characterisation of nano-calcium lactate from chicken eggshells synthesized by precipitation method as a food supplement)

(Org: Eng)

JITV 26(4): 139-144

Osteoporosis can be prevented by consuming calcium lactate. Calcium that is consumed is generally in a micro-size. Micro-sized calcium is only absorbed by the body by about 50% which can cause deficiency. Eggshells are poultry waste that is rich in calcium and can be used as a cheap source of dietary calcium through nanotechnology. Nanotechnology has been developed to increase calcium absorption. This study aimed to synthesize nano-calcium lactate from chicken eggshells calcium oxide and commercial by precipitation method. Synthesis was carried out by reacting a solution of 1 mol/L eggshell calcium oxide and commercial (control) as much as 20 ml mixed with a solution of 6 mol/L lactic acids as much as 30 ml with a ratio of 1:1.5 (v/v) for 30 minutes at 50°C at a speed of 500 rpm/minute using a magnetic stirrer. Ethanol 50% was added as much as 20 ml (v/v), oven at

105°C for 72 hours then crushed to produce eggshell nano-calcium lactate (NCaL) powder. Characterisation of NCaL using Transmission electron microscopy (TEM), X-ray diffraction (XRD), and Fourier transform infrared (FTIR). The result showed that NCaL in the form of white crystals could be synthesized from chicken eggshells by precipitation method. Characterization with XRD showed that the diffraction angle was 2θ with the peaks of NCaL, namely 9.3800°, 10.3869°, and 22.9570°. Characterization with FTIR obtained a peak in the wavenumber from NCaL, namely 1,589.34 cm^{-1}. Characterization using TEM showed that the crystal size of NCaL was 75 nm..

(Author)

Key Words: Chicken eggshell, Food supplement, Nano-calcium lactate, Precipitation method

UDC: 591.53

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Pengaruh waktu fermentasi pakan lengkap berbasis litter broiler terhadap kandungan nutrien dan kecernaan *in vitro* (Effect of broiler litter based complete feed fermentation time on nutrient content and *in vitro* digestibility)

(Org: Eng)

JITV 26(4): 145-151

Broiler litter waste is increasing as the population of broiler chickens increases, on the other hand the need for ruminant feed is increasing so that alternative feeds are needed in the form of complete feed made from litter. This study was aimed to determine the effect of fermentation time on the nutritional content and digestibility of the complete feed. A completely randomized design with 4 treatments and 5 replications were applied in this study. Treatment T0 = not fermented; T1 = fermentation for 10 days; T2 = fermentation for 24 days; T3 = fermentation for 38 days. Parameters observed were nutrient content, VFA, NH3, dry matter digestibility and organic matter digestibility *in vitro* using cow rumen. Results showed that fermention of complete feed with 2.5% EM4 starter and 5% probiofeed for 38 days (T3) had a significant effect ($P<0.05$) on nutrient content, dry matter digestibility, organic matter digestibility, VFA and NH3. The T3 significantly affected ash content, crude fat, crude protein, BETN, TDN, dry matter digestibility, organic matter digestibility, VFA, and NH3 but had no significant effect on water content and crude fiber. It is concluded that the complete feed could be used as alternative feed for ruminants, and it is easy to obtain, cheap and able to reduce environmental pollution.

(Author)

Key Words: : Complete feed, Digestibility, Fermentation, Litter, Nutrient

UDC: 637.52

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Kualitas sosis ayam yang difortifikasi nano kalsium kerabang telur itik dalam kemasan vakum yang berbeda selama penyimpanan suhu -18°C (Quality of chicken sausage fortified with nano-calcium duck eggshell in different vacuum packaging during storage at -18°C)

(Org: Eng)

JITV 26(4): 152-157

This study aimed to determine the effect of fortification of duck eggshell nano-calcium and different types of packaging on the quality of the chicken sausage. The research material consisted of duck eggshell nano-calcium, chicken fillet, sugar, garlic powder, salt, pepper, tapioca, ice, oil, soy protein isolate, sodium tripolyphosphate, monosodium glutamate, collagen casing, polyethylene, nylon, and retort pouch packaging. The treatment for fortification of duck eggshell nano-calcium was P0 (0%) and P1 (0.3%) of the total dough. The vacuum packaging treatments are K1 (polyethylene), K2 (nylon), and K3 (retort pouch). All chicken sausages were vacuum-packed and stored at -18°C for 0 and 14 days of observation. The parameters tested were water content, pH value, peroxide value, and total plate count. The test data were analyzed by analysis of variance in a completely randomized design with factorial patterns and if there was a significant difference ($P<0.05$) then further tested with Duncan's New Multiple Range Test. Sausage fortified with duck eggshell nano-calcium with vacuum retort pouch packaging was the best treatment with the lowest peroxide value at day 14 shelf life. Sausage fortified with nano-calcium duck eggshell with vacuum retort pouch packaging at day 14 shelf life had moisture (51.59%), pH value (6.83), peroxide value (64.64 meq O_2/kg), and total plate count (3.50 X 10^3 cfu/g).

(Author)

Key Words: Chicken sausage, Duck eggshell, Fortified, Nano-calcium, Vacuum-packaged

UDC: 636.082.4

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Pengaruh body condition score pada performa reproduksi dan lingkar dada sapi Bali pada sistem pemeliharaan berbeda (Effect of body condition score on reproductive performance and chest girth of Bali cattle in different rearing systems)

(Org: Eng)

JITV 26(4): 158-166

Nutrition and rearing systems are some of the main factors affecting the productivity of cows. Body condition score (BCS) is a method used to assess nutritional status and evaluate the rearing systems of each animal. This study analyzes the effect of BCS on the reproductive performance and chest girth of Bali cows in different rearing systems. This study was conducted at the Field Station of Sekolah Peternakan Rakyat Kuamang Abadi, Bungo Regency, Jambi, Indonesia. A total of 62 heads of Bali cow with BCS of 2, 3, and 4 (scale 1-5) raised on intensive, semi-intensive and extensive systems were used in this study. This study was

conducted using survey and direct observation. The variables observed were as follows: BCS, calving interval (CI), days open (DO), service per conception (S/C) and chest girth (CG). Data were analyzed using simple correlation and regression analysis in SPPS, followed by descriptive analysis. The result showed that the BCS of Bali cows in different rearing systems did not affect CI, DO, S/C and CG. BCS had a weak correlation coefficient (r), with the reproductive performance of CI, DO, and S/C at 0.09, 0.09, and 0.08, respectively. In addition, the relationship between BCS and CG was highly significant, with a correlation coefficient (r) of 0.532. Therefore, BCS had a positive relationship with CI, DO, S/C, and CG. Moreover, BCS cannot be used as the only indicator to assess the reproductive performance of Bali cows in different rearing systems.

(Author)

Key Words: Bali cow, Body condition score, Chest girth, Reproductive performance

UDC: 638.124.5

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Keragaman, preferensi bersarang, dan tanaman pakan lebah propolis (Hymenoptera: Apidae: Meliponini) dari Halmahera Barat, Maluku Utara Indonesia (Diversity, nest preference, and forage plants of stingless bee (Hymenoptera: Apidae: Meliponini) from West Halmahera, North Moluccas, Indonesia)

(Org: Eng)

JITV 26(4): 167-1178

Survey of stingless bee diversity, nesting preferences, and forage plants was conducted in West Halmahera across 134 collection sites. This research was aimed to determine species diversity, nesting preference and habitat, and dominant forage plants. There were three species found, the most common species being Tetragonula clypearis (Friese), followed by T. sapiens (Cockerell), and last T. biroi (Friese). Based on the morphology characters of each species, the key identification was provided. The most colonies were found in public houses (80.39%), followed by plantations (13.73%), and the community forest (5.88%), respectively. Most colonies nested in stone cavities, parts of the houses, wooden materials, tree trunks, logs, tree roots, bamboo, and sometimes iron cavities. The forage plants consist of forage plantation, crops, fruits, vegetables, ornamental flowers, wild plants and shrubs. The three species found were new record in West Halmahera. Bees lived in various hollow places that were safe for their colony. Bees made use of a variety of flowering plants and secrete resins around the nest site.

(Author)

Key Words: Diversity, Forage plants, Nesting preference, *Tetragonula* spp., West Halmahera

UDC: 631.81

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Pengaruh jenis dan level dosis pupuk daun terhadap morfologi dan produksi *Clitoria ternatea* (Effect of types and dosage level foliar fertilizers on morphology and production of *Clitoria ternatea*)

(Org: Eng)

JITV 26(4): 179-186

The aim of this study was to determine effect of types and dose levels of foliar fertilizers on morphology and production of *Clitoria ternatea*. This study was conducted from September to November 2020 at Forage Research Garden for Animal Feed and Pasture, Faculty of Animal Science, Gadjah Mada University, Yogyakarta. Materials used were Clitoria ternatea, liquid organic fertilizer of rabbit and gandasil D fertilizer. This study was designed in a Completely Randomized Design (CRD) with factorial pattern of 2x4. The fertilizer dosages were: 0,1.5,3.0 and 4.5 g/l/plot. The parameters measured were plant height, stem diameter, leaf area, number of branches, fresh and dry matter productions. Data were analyzed by the analysis of variance at 5%, with Duncan's Multiple Range Test (DMRT). Results showed that types of foliar fertilizers did not affect morphological characteristics and production of Clitoria ternatea ($P>0.05$), but the fertilizer dosages had significant effect ($P<0.05$) on morphological characteristics except for leaf area and production of Clitoria ternatea. The higher the dose level of foliar fertilizer the greater the plant height, stem diameter and number of branches. Dosage of 4.5 g/l/plot resulted in the highest plant height, stem diameter and number of branches each 160.02, 1.14 cm and 18.96 branches, respectively. Dosage of4.5 g/l/plot gave the highest fresh and dry matter production of 19.22 and 16.75 tons/ha. It is concluded that increasing the dosage level of foliar fertilizer up to 4.5 g/l/plot resulted in an increased quantity measures of several morphological characteristics and production.

(Author)

Key Words: *Clitoria ternatea*, Dosage level, Foliar fertilizers, Morphologi, Production

UDC: 636.58.034

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Efisiensi produksi peternak ayam ras petelur skala kecil di Indonesia (Production efficiency of poultry small-scale laying hen in Indonesia)

(Org: Eng)

JITV 26(4): 189-194

Competitiveness of layer business was determined by the level of efficiency, which was influenced by the level of technology adoption, production costs, and economy of scale.

This study was carried out from April to July aim to analyse the performance of small-scale layer poultry farming. The study site was in the layer production centre, namely in Payakumbuh West Sumatera, Blitar East Java and Sidrap South Sulawesi. Primary data were collected through interviews with 50 farmers and 12 poultry shops at all study sites. Analysis of the efficiency level is using DEA (Data Envelopment Analysis) software and business feasibility using financial analysis. The following were the main research findings: (1) the development of layer farming technology had not been responded well by farmers so that the production level and mortality of chickens were still below standard; (2) relatively, the level of layer poultry farming efficiency in Sidrap and Payakumbuh was better than in Blitar with a value closer to one, where the inefficiency was due to the use of excessive inputs; and (3) small-scale layer poultry farming was financially feasible, where the determining factors were feed and eggs price. The study recommended the need to add both technical service staff from poultry shops and local agricultural extension workers. Feed costs should be reduced by IDR 1,000 in Blitar and IDR 57 di Sidrap per kilogram of eggs produced per period. In addition, an accurate and better allocation of corn for feed was needed to optimise the ratio of feed and egg price optimal.

(Author)

Key Words: Data Envelopment Analysis (DEA), Efficiency, Layer

AUTHOR GUIDELINES

Indonesian Journal of Animal and Veterinary Sciences or IJAVS contains:

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AUTHOR GUIDANCE

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   Consists of research background, problems, efforts that have been made, approaches taken to solve problems, and research objectives.
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Literature in the reference is written alphabetically based on the author's name. The same author is written sequentially starting from earlier order.

Example of reference writing

Primary paper:

Bhanja SK, Anjali DC, Panda AK, Sunder GS. 2009. Effect of post-hatch feed deprivation on yolk-sac utilization and young broiler chickens. Asian-Aust J Anim Sci. 22:1174-1179.

Book:

a. Lawrence TLJ, Fowler VR. 2002. Growth of farm animals. 2nd ed. New York (USA): CABI Publishing.
b. Bamualim A, Tiesnamurti B. 2009. Konsepsi sistem integrasi antara tanaman padi, sawit, dan kakao dengan ternak sapi di Indonesia. In: Fagi AM, Subandriyo, Rusastra IW, penyunting. Sistem integrasi ternak tanaman padi, sawit, kakao. Jakarta (Indones): LIPI Press. p. 1-14.
c. Paloheimo M, Piironen J, Vehmaanpera J. 2010. Xylanases and cellulases as feed additives. In: Bedford MR, Partridge GG, editors. Enzymes in farm animal nutrition. 2nd ed. New York (USA): CABI Publishing. p. 12-53.

Proceeding:

Umiyasih U, Antari R. 2011. Penggunaan bungkil inti sawit dan kopra dalam pakan penguat sapi betina berbasis limbah singkong untuk pencapaian bobot badan estrus pertama >225 kg pada umur 15 bulan. Prasetyo LH, Damayanti R, Iskandar S, Herawati T, Priyanto D, Puastuti W, Anggraeni A, Tarigan S, Wardhana AH, Dharmayanti NLPI, editors. Proceeding of National Seminar on Livestock Production and Veterinary Technology.

Bogor (Indones): Indonesian Center for Animal Research and Development. p. 192-199.

Thesis:

Krisnan R. 2008. Kombinasi penggunaan probiotik mikroba rumen dengan suplemen katalitik pada pakan domba (Thesis). [Bogor (Indones)]: Institut Pertanian Bogor.

Electronic magazines:

Wina E, Tangendjaja B, Dumaria. 2008. Effect of *Calliandra calothyrsus* on *in vitro* digestibility of soybean meal and tofu wastes. Livest Res Rural Develop. Vol. 20 Issue 6. http://www.lrrd.org/lrrd20/6/wina 20098.htm.

Institution:

a. [NRC] National Research Council. 1985. Nutrient requirements of sheep. 6th revised. Washington DC (USA): National Academic Press.
b. [CDC] Centers for Disease Control. 2006. Standard operating procedure for the direct Rapid Immunohistochemistry Test (dRIT) for the detection of rabies virus antigen. [accessed December 20th, 2011]. http://www.rabiesblue print.com/IMG/pdf/DRIT_SOP.pdf.

Patent:

Blanco EE, Meade JC, Richards WD. 1990. Ophthalmic Ventures, assignee. Surgical stapling system. United States patent US 4,969,591. 1990 Nov 13.

10. **Citation in text:**

The citation consists of the author's last name and publication year.

Example:

a. One author: ..... grow slower than lamb fed cattle's milk (Supriyati 2012). Supriyati (2012) formulates.....
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