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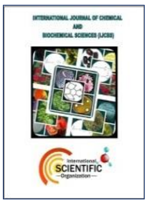

Cocoa Pulp and Tapioca Meal in Urea Molasses Multinutrient Block Production on Physiological and Hematological Status of Holstein Friesian Dairy Cows

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Abstract

This experiment aimed to explore using cocoa pulp and tapioca meal as fillers and adhesives in modifying UMMB production for use as a feed supplement for Holstein Friesian cows. The study involved 15 Holstein Friesian dairy cows in the middle-late lactation phase, each weighing approximately 500kg. The cows were housed together and fed a diet of elephant grass (Pennisetum purpureum) and a concentrate made up of tofu pulp, rice bran, and coconut cake meal, with free access to water. The experiment followed a completely randomized design with two factors. Factor A involved three treatments of UMMB supplementation: no supplementation (ED0), supplementation without modification (ED1), and supplementation of modified UMMB (ED2), with 5 replications for each treatment. Factor B was the measurement time, which included morning (08.00–09.00 am), midday (01.00–02.00 pm), and afternoon (04.00–05.00 pm). The results showed that the supplementation of modified UMMB did not have a significant effect on the physiological responses (heart rate, respiration frequency, rectal temperature) or the hematological status (red blood cells, white blood cells, hemoglobin, hematocrit, and platelets) of the Holstein Friesian dairy cows. As a result, it can be concluded that modified UMMB is a safe feed supplement for these cows.

Keywords: Cocoa Pulp, Hematology, Physiological, Tapioca Meal, UMMB

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1. Introduction

The molasses multinutrient block (UMMB) is a highly beneficial feed supplement for Holstein Friesian dairy cows, as it contains non-protein nitrogen, energy, vitamins, and minerals [1]. The production of UMMB involves two main components, fillers and adhesives. Molasses is one of the commonly used fillers in the production of UMMB, but its use has the potential to compete with industrial needs [2]. Additionally, cement is the adhesive material commonly used in the production of UMMB, but its long-term use can cause health problems in livestock health and the presence of toxic heavy metals [3]. Therefore, it is urgent to find replace materials that can substitute the use of molasses and cement in the production of UMMB. Cocoa pulp is a by-product of the cocoa. The cocoa pulp contains sugars consisting of 60% sucrose and 39% a mixture of glucose and fructose, water 33.4%; crude protein 12.88%; crude fat 3.79%; crude fibre 14.14%; ash content 24%; Nitrogen free extract (NFE) 42.06%, flavonoids 0.16% and theobromine up to 0.55% [4, 5]. In the previous study, it was used as a feedstuff for concentrate feed in Bali cattle fattening due to its high energy content and has been reported the utilization of cocoa pulp for complete feed [5, 6]. Due to the high sugar and carbohydrates in cocoa pulp, it is a promising substitute for molasses in the production of UMMB. Meanwhile, tapioca meal has been utilized as an adhesive material in poultry pellet products [7] due starch content in tapioca meal, which has good binding properties that can make an effective adhesive material [8]. The aim of this experimental was to see how the effect of using cocoa pulp as a filler to substitute the use of molasses and tapioca meal as an adhesive to replace the use of cement in the process of making UMMB on the physiological and hematological status of FH dairy cow.

2. Materials and Methods

2.1. Materials

This experimental used 15 Holstein Friesian dairy cows in the middle-late lactation phase with a body weight of ± 500kg. The dairy cows are kept in a group pen fed with elephant grass (*Pennisetum purpureum*) and concentrate consisting of tofu pulp, rice bran, and coconut cake meal while drinking water is given ad libitum.

2.2. Ethics Approval

This experimental protocol was approved by the Institutional Animal Ethics Committee, under the supervision of the Scientific Research Review Committee, Faculty of Veterinary Medicine, Hasanuddin University, Number 470/UN4.6.4.5.3L/PP36/2023 on July 10, 2023.

2.3. Method

This experimental was designed with a completely randomized design (CRD). The treatments in this study are without supplementation of UMMB (as ED0); supplementation of UMMB without modification (ED1); and Supplementation of modified UMMB (ED2). The UMMB formulation and chemical composition is presented in Table 1 and Table 2.

2.4. Variables

2.4.1. Ambient Temperature, Humidity, and THI

Data collection on the Temperature Humidity Index (THI) and physiological responses measurements are carried out every week, each data collection is carried out three times a day, i.e: in the morning (08.00–09.00 a.m.), in the midday (01.00–02.00 p.m.), and in the afternoon (04.00–05.00 p.m.). Data collection on THI was carried out by measuring ambient temperature and humidity in the pen using a hygrometer. The formula used to measure THI refers to [9] as follows:

$$THI= (1.8\times T+32)-[(0.55-0.0055\times RH) \times (1.8\times T-26)]$$

Whereas T is Temperature (˚C) and RH is Relative Humidity (%).

2.4.2. Physiological Responses

The physiological responses were measured by the following method according to [10]: the rectal temperature of Holstein Friesian dairy cows was measured by inserting a clinical veterinary thermometer into their rectum wall at a depth of approximately 1/3 of thermometer length for 3 minutes; heart rate, which is expressed in the number of beats per minute, was measured by using a stethoscope and stopwatch for 30 seconds and then multiplying the result by two to obtain this variable in minutes; and then the respiratory rate, expressed in the number of breaths per minute, was measured by using a stethoscope and stopwatch to auscultate respiratory movements for 30 seconds and then multiplying the obtained value by two to obtain this variable in minutes.

2.4.3. Hematology Status

The data collection, blood samples were collected through the jugular vein using a venoject needle and vacutainer. They were stored in blood tubes containing EDTA to prevent damage to the blood samples before testing. The Dika Health laboratory in Sidenreng Rappang Regency analyzed the blood samples for red blood cells (RBC), white blood cells (WBC), hemoglobin (Hb), hematocrit (Ht), and platelets (PLT) using the Rayto RT-76000 device.

2.5. Data Analysis

The data obtained will be subjected to analysis of variance (ANOVA) with a 95% confidence interval. If the results show a significant effect ($p<0.05$), then the Duncan test will be carried out. The applications used for data analysis are Microsoft Excel 2013 software and Statistical Process for Social Science (SPSS) version 22.0.

3. Results and discussion

3.1. Ambient Temperature, Humidity, and THI

The physiological response and productivity of a dairy cow can be affected by the stress level of the dairy cow. THI is often used as an important environmental assessment index to evaluate heat stress in dairy production [11]. Table 3 below shows the ambient temperature, humidity, and THI based on the study's findings. The Experimental revealed that ambient temperature and humidity were similar between morning, midday, and afternoon. Ambient temperature and humidity during the study included a temperature range of 26–30°C, a humidity range of 53–74%, and a THI range of 76–80. The study found that an increase in temperature can lead to evaporation, which causes a decrease in humidity. This finding is consistent with previous research conducted by [12], which states that lower air temperature in the environment including microclimate leads to an increase in air humidity. According to the experiment conducted, the average recorded THI was 76–80 which suggests that the Holstein Friesian dairy cows were under mild stress in the morning and afternoon (THI ≥72) and moderate stress during the midday (THI≥79) [13]. However, THI values observed in this study were below the threshold value of ≥89, indicating severe stress in Holstein Friesian dairy cows. Persistent mild to moderate stress throughout the day can decrease dairy cows' performance. This aligns with [14] who suggest that ambient temperature and humidity can also impact the productivity of dairy cows.

Table 1. UMMB Formulation

Ingridients (%)	ED0	ED1	ED2
Cement	-	10	5
Tapioca meal	-	-	5
Urea	-	5	5
Molasses	-	30	15
Cocoa pulp	-	-	15
Coconut cake meal	-	15	15
Rice bran	-	35.5	35.5
Commercial Minerals	-	1	1
Salt	-	2	2
Limestone	-	1	1
Commercial Vitamins	-	0.5	0.5
Total	0	100	100

Table 2. Chemical composition of UMMB Figures

Chemical Composition	ED0	ED1	ED2
Dry Matter (%)	-	95.51	93.86
Ash (%)	-	22.29	21.93
Crude Protein (%)	-	28.19	32.39
Crude Fat (%)	-	1.21	0.67
Crude Fibre (%)	-	17.61	19.82
Ca (%)	-	3.57	3.50
Gross Energy (Kcal/kg)	-	3302.46	3261.85

Table 3. Mean (±SD) of ambient temperature, humidity, and THI

Time Measurements	Temperature (℃)	Humidity(%)	THI
Morning	26.45±6.01	74.33±6.01	76.61±1.85
Midday	30.93±5.61	53.83±5.61	80.33±0.97
Afternoon	29.53±8.92	58.08±8.92	79.01±1.20
Mean	29.97±0.23	62.08±1.80	78.65±2.05

Table 4. Mean (±SD) of physiological response of Holstein Friesian dairy cows

Parameters	Time (Factor A)	UMMB (Factor B)			Mean
		ED0	ED1	ED2	
Heart Rate (beats/min)	Morning	60.80±2.91	56.64±2.91	59.20±2.91	58.88±1,.68
	Midday	61.60±2.91	60.96±2.91	61.84±2.91	61.46±1.68
	Afternoon	63.20±2.91	61.28±2.91	61.20±2.91	61.89±1.68
	Mean	61.86±1.68	59.62±1.68	60.74±1.68	
Respiration Frequency (breath/min)	Morning	30.86±2.03	29.44±2.03	30.16±2.03	30.15±1.17
	Midday	31.66±2.03	34.08±2.03	32.32±2.03	32.68±1.17
	Afternoon	28.30±2.03	31.20±2.03	32.24±2.03	30.58±1.17
	Mean	30.27±1.17	31.57±1.17	31.57±1.17	
Rectal Temperature (°C)	Morning	37.34±0.72	37.02±0.72	36.70±0.72	37.02±0.41
	Midday	35.52±0.72	38.00±0.72	37.84±0.72	37.08±0.41
	Afternoon	38.14±0.72	37.86±0.72	37.45±0.72	37.86±0.41
	Mean	36.96±0.41	37.62±0.41	37.37±0.41	

Table 5. Mean (±SD) of hematology status of Holstein Friesian Dairy Cows

Parameters	Treatment			*p*	Reference
	P0	P1	P2		
RBC (10^6 /µL)	6.03±0.13	5.67±0.51	5.73±0.13	0.69	5.0–10.0
WBC (10^3 /µL)	8.10±0.14	7.48±0.73	7.90±0.79	0.78	6.5–12
Hb (g/dl)	9.90±0.23	10.23±0.68	9.54±0.25	0.55	8.0–15
Ht (%)	2898±0.80	28.04±2.39	27.64±0.77	0.81	24–46
PLT (10^3 /µL)	5.13±0.58	4.17±0.58	4.60±0.67	0.56	1.6–6.5

3.2. Physiological Responses

The physiological response of Holstein Friesian supplemented with modified UMMB is presented in Table 4. Factor A, Factor B, and the interaction between A and B on the physiological responses of Holstein Friesian dairy cows to heart rate, respiration frequency, and rectal temperature were similar (Table 4). In this study, heart rate, respiration frequency, and rectal temperature in Factor A, and Factor B, and the interaction between Factors A and B were 56–63 beats/min, 28–34 breath/min, and 35–38 °C, respectively. These results are similar to [15], the physiological responses of dairy cows include a heart rate 66–68 beats/min, respiration frequency 38–44 breath/minute, and rectal temperature 38–39°C. The difference in results occurs due to different measurement times. In this study, the measurements take place in the morning, mid-day, and afternoon. Heart rate, respiration frequency, and rectal temperature in P2 were higher compared to P0 due energy and starch content of molasses, tapioca meal, and cocoa pulp in UMMB which have a high effect on the metabolic process in the Holstein Friesian. high metabolic activity in Holstein Friesian increases the body heat and heart rate [16]. An increase in metabolic processes will increase the oxygen needed for the body in Holstein Friesian [17]. The respiratory rate of dairy cows tends to increase when they get heat stress. This is because their body needs to cool down and regulate their internal temperature. Additionally, the metabolic processes in the cow's body require oxygen, which also increases the respiratory frequency [18]. According to the study, there was an increase in heart rate, respiration frequency, and rectal temperature of the Holstein Friesian from morning to afternoon. This increase in physiological responses is caused by heat stress in dairy cows, which is influenced by the microclimate of the environment. The increase in ambient temperature, humidity, and THI (as shown in Table 3) is directly related to the increase in physiological responses of dairy cows (as shown in Table 4). However, it should be noted that the rectal temperature in all treatments remained relatively constant. This is because dairy cows can regulate their body temperature within the range of 38.2 to 39.10°C to maintain the stability of their body temperature. This finding is in line with the opinion of [19] which states that dairy cows can regulate their body temperature and maintain it despite the influence of their environment, by regulating the release of body heat generated from metabolic processes.

3.3. Hematology Status

Based on the results of the experimental, it can be seen that feeding UMMB with the substitution of molasses filler with cocoa pulp and cement adhesive with tapioca meal on the hematological status of dairy cows was presented in the following Table 5. The results of the study revealed that the treatment on the status of hematology between treatments was similar, which remained within the normal threshold (as shown in Table 4). Interestingly, the levels of RBC, WBC, HB, Ht, and PLT in P2 were lower than those at P0. The modified UMMB was found to be equivalent to the UMMB without modification. Moreover, the modified UMMB contains cocoa pulp which is rich in theobromine, flavonoids, and antioxidants have a positive impact on the quality of the modified UMMB. Theobromine can provide a sense of comfort, stimulate the nerve centre, induce muscle relaxation, and do not affect the status of hematology [20]. Hemoglobin levels in blood are influenced by milk yield. The higher the milk yield in dairy cows, the lower the hemoglobin level in the blood. This is due to the high blood circulation in the udder glands for the milk synthesis process, which can affect the overall hemoglobin levels in the body [21]. The energy content of cocoa pulp and tapioca starch can increase the body metabolism of livestock. The increase in metabolism will increase the amount of nutrients absorbed so that the blood carries the nutrients. The increase in nutrients will increase the number of blood cells and plasma, which are the transport medium for nutrients in the animal's body. Cocoa pulp and tapioca starch contain high energy, and high energy intake will increase metabolism in the body of livestock. This metabolic process requires blood as a medium for transporting nutrients needed from the digestive system into cells. Therefore, this increase in metabolism can then increase blood circulation in the livestock circulation system. However, in addition to feed factors, environmental factors can also affect the hematological status of livestock, livestock that experience heat stress tend to have an abnormal hematological status. Cocoa pulp and tapioca meal have a high energy content that can increase the metabolism of dairy cows, leading to increased nutrient absorption and circulation through the blood. This increase in nutrient availability can also lead to an increase in the number of blood cells and plasma, which are important for transporting nutrients throughout the animal's body. However, it is important to note that environmental factors, such as heat stress, can also impact the hematological status of dairy cows.

4. Conclusions

The use of 50% molasses as filler and 50% tapioca starch as an adhesive to produce UMMB was similar to conventional UMMB feeding. Additionally, it is better to feed UMMB than non-supplemented UMMB on the physiological and hematological status of Holstein Friesian dairy cows.

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