Research Article

Consumption, Digestibility and Milk Production in Dairy Cows Feeding Different Energy and Protein Rations

Fitri Fahira Yuza[1*], Mardiati Zain[2*], Arief[3]

[1]Student of Master Program in Animal Science, Andalas University, Indonesia; [2]Department of Nutrition and Feed Technology, Faculty of Animal Science, Andalas University, Indonesia; [3]Department of Animal Production Science and Technology Faculty of Animal Science, Andalas University, Indonesia.

Abstract | This study aims to get the balance of energy and protein rations of dairy cows on feed consumption, digestibility and milk production. This study used a completely randomized design (CRD) 2x2 factorial pattern with 3 replications. The treatment factor used is the ration energy content (TDN) for factor A, namely: Al (65%), A2 (70%) and ration protein content for factor B, namely: Bl (14%), B2 (16%). The variables observed in this study include dry matter consumption (DMC), organic matter consumpt.ion (OMC), dry matter digestibility (DMD), organic matter digestibility (OMD), crude protein digestibility (CPD) and milk production. The results showed that there was an interaction between energy and protein rations on dry matter consumption (KBK), organic matter consumption (KBO), dry matter digestibility (KcBK), organic matter digestibility (KcBO) and milk production. The conclusion of this study is that feeding with a balance of 70% energy and 14% protein in the ration gives a significantly different effect on Dry Material Consumption (KBK) of 14.88 kg/head/day, Organic Material Consumption (KBO) of 13.41 kg/head/day, Digestibility of Dry Material (KcBK) of 69.18%, Digestibility of Organic Material (KcBO) of 71.29%, Milk Production of 19,98 liters/head/day not 9,98 liters/head/day.

Keywords | *Friesian holstein* cattle, Feed consumption, Feed digestibility, Milk production

Received | July 04, 2024; **Accepted** | August 04, 2024; **Published** | April 11, 2025
***Correspondence** | Fitri Fahira Yuza, Student of Master Program in Animal Science, Andalas University, Indonesia; **Email:** fitrifahirayuza71253@gmail.com, Mardiati Zain, Department of Nutrition and Feed Technology, Faculty of Animal Science, Andalas University, Indonesia; **Email:** mardiati@unsci.unand.ac_id
Citation | Yuza FF, Zain M, Arief (2025). Consumption, Digestibility and milk production in dairy cows feeding different energy and protein rations. Adv. Anim. Vet. Sci. 13(5): 966-971.
DOI | https://dx.doi.org/10.17582/journal.aavs/2025/13.5.966.971
ISSN (Online) | 2307-8316; **ISSN (Print)** | 2309-3331

INTRODUCTION

Frisian Holstein (FH) cattle are a very common dairy breed and play an important role in meeting national milk demand (Ratnasari *et al*., 2019). However, domestic milk production is still insufficient, so milk imports are still needed (Gandhy and Kurniawati, 2018). One of the factors that cause low milk production of dairy cows is feed problems, especially due to nutrient deficiencies (Despal *et al*., 2011). Therefore, to meet the milk needs of dairy cows, high quality feed is required.

Feed is an important factor in a livestock business that is useful for meeting the basic needs of life and livestock production. Food nutrients needed by livestock consist of carbohydrates (as the main source of energy), protein, fat, water, vitamins and minerals. The main nutrients needed by dairy cows are energy and protein.

Energy is required to meet the metabolic needs of dairy cows including growth, body maintenance and milk production. Energy in dairy cattle rations is usually measured in units of *Total Digestible Nutrients* (TDN). TDN is a description of the total energy derived from feed consumed by livestock. TDN requirements in lactating dairy cows range from 63-67% (NRC, 2001). The main source of energy in dairy cattle feed comes from carbohydrates. The most important end product of carbohydrate digestion in the rumen is *volatile fatty acids* (VFA) because VFA is the main source of energy (70%) for ruminants and is used by microbes as a source of carbon atoms (C) to form rumen microbial protein structures. Protein is an important nutrient for dairy cows because it plays a role in growth, body tissue repair, mjlk synthesis and reproductive function. In general, feed protein consumed by ruminants is in the form of crude protein. These crude proteins are easily degraded (RDP/ *Ruminally Degraded Protein*) and undegraded proteins (RUP/ *Ruminfllly Undegraded Protein).*Protein requirements in lactating dairy cows range from 12-15% (NRC, 2001).

Table 1: The content of food substances that make up the ration.

Food Content (%)	Feed Ingredients					
	Elephant Grass	Field Grass	Bran	Afkir Bread	Tofu Dregs	Minerals
BK	19,65	23,29	87,84	61,61	19,85	100
BO	88,53	91,43	88,99	90,59	95,37	0
PK	11,27	10,23	9,86	20,29	25,96	0
SK	30,45	22,94	17,62	13,58	19,86	0
LK	2,67	3,19	7,02	10,81	9,17	0
TDN	56,40	57,52	64,74	82,7	70,31	0
BETN	43,49	48,84	55,38	78,42	46,41	0

Source: Ruminant Nutrition Laboratory, Faculty of Animal Husbandry, Universitas Andalas (2023).

The availability of energy and protein in the ration is very important because these two factors play a major role in the synthesis of rumen microbes. Rumen microbes ferment feedstuffs containing energy and protein, then use nitrogen to fulfill their life needs and form microbial protein under balanced energy and protein conditions. To achieve optimal microbial protein growth and livestock production, sufficient dietary energy and protein are required. Microbial synthesis efficiency can be achieved by designing rations based on the synchronization index between energy and protein, thus supporting optimal livestock growth (Hermon, 2009). Widyobroto *et al*. (2007) added that these two factors must be available simultaneously (synchronized). If protein is produced more than energy, most of it will be wasted as urea and can even cause urea toxicity. Conversely, excess energy compared to ammonia also cannot be utilized for microbial protein synthesis (SPM), but instead is used for other cellular metabolism. Providing both sources for SPM growth can be achieved through protein and energy synchronization (Widyobroto *et al*., 2007).

The balance of energy and protein in the ration of *Friesian Holstein* cows has also been carried out on the digestibility of dry matter (DMD) and digestibility of organic matter (KcBO) by Zahera *et al*. (2022) and the increase in the digestibility of dry matter and organic matt.er along with the increase in the level of energy and protein provision. The best digestibility of dry matter and organic matter was obtained at the level of energy 61.14% and protein 15.71%. This study aims to examine the effect of protein and energy balance on consumption, digestibility and milk production of dairy cows.

MATERIALS AND METHODS

Research Location

This research was conducted at "Yuza Farm" Dairy farm located in Padang Panjang Timur, Padang Panjang City, West Sumatra, Indonesia. Laboratory analysis was conducted from September to December 2023 at the Ruminant Nutrition Laboratory and Dairy Cattle Laboratory, Faculty of Animal Science, University of Andalas, Padang, West Sumatra, lndonesia.

Animals, Treatments and Research Design

Twelve Friesian Holstein dairy cows in the second and third lactation period with a body weight of about 350 kg were experimented for 5 weeks. The ration given was based on dry matter requirement of 4% of body weight. This study used a completely randomized design with a 2x2 factorial pattern and 3 replications. Factor A was the provision of energy (TDN) in the ration with levels A1 (65%) and A2 (70%), while factor B was the provision of protein in the ration with levels Bl (14%) and B2 (16%). The treatments in this study were as follows: AIBl: TON 65% + Protein 14%; A IB2: TON 65% + Protein 16%; A2B I: TON 70% + Protein 14%; and A2B2: TON 70% + Protein 16%. The ration formulation and feed chemical content are presented in Tables 1 and 2.

Feed Preparation

Feed preparation includes the provision of elephant grass, field grass, and concentrates consisting of discarded bread, tofu pulp, bran, and minerals. Feed is given twice a day, in the morning and evening.

Data Collection and Parameter Measurement

Feed consumption was calculated by weighing the total feed given and the remaining feed each day. Feed digestibility was calculated by subtracting the content measured in feces from the total feed consumption, then multiplying by 100%. Milk production was collected and recorded daily for 30 days during morning and evening milking. Milk samples were then put into plastic containers and placed in a coolbox for milk quality analysis, including fat, protein, and lactose content using a lactoscan device.

Table 2: Formulation and nutrient content of rations.

Ration Material	Treatment (%)			
	A1B1	A1B2	A2B1	A2B2
Forage	50	50	50	50
Afkir Bread	16	13	20	15
Tofu Dregs	16	23	9	20
Bran	17	16	20	14
Minerals	1	1	1	1
Total	100	100	100	100
Content				
DM	35,38	32,16	38,41	33,40
OM	89,05	89,43	88.70	89,29
CP	14,38	15,55	14,37	15,88
CFib	19,32	19,80	19,41	19,56
CF	5,34	5,32	5,41	5,38
TDN	65,49	65,34	70,05	70,30
NNFE	54,98	53,66	56,53	54,39
Ca	0,59	0,59	0,58	0,58
P	0,28	0,29	0,26	0,28
Lignin	4.83	5.11	4.51	4.96
Silica	2.78	2.93	2.61	2.85

RESULTS AND DISCUSSIONS

Based on the data in Table 3. It can be explained that:

Table 3: Average Dry Matter Consumption by Feeding Different Energy and Protein Balances (kg/head/day).

Factor A (TDN)	Factor B (Protein)		Average
	B1 (14%)	B2 (16%)	
A1 (65%)	12,07[b]	12,17 [b]	12,12
A2 (70%)	13,21[a]	10,70[c]	11,96
Average	12,64	11,43	
SE			0,09

Notes: Different superscripts indicate significantly different effects (P<0.0).

Dry Matter Consumption (Kg/Head/Day)

The results showed a significant interaction (P<0.05) between Factor A (TDN) and Factor B (Protein) on Dry Material Consumption Based on DMRT further test, the interaction between factor A and factor B showed that AIBI treatment was not significantly different (P>0.05) with A1B2 treatment. AIBI treatment is significantly different (P<0.05) with A2BI treatment. A2BI treatment is significantly different (P<0.05) with A2B2 treatment. A2B2 treatment was not significantly different (P>0.05) with AIB2 treatment.

Table 4: Average Organic Matter Consumption with Different Energy and Protein FeedBalances(Kg/Head/Day).

Factor A (TDN)	Factor B (Protein)		Average
	B1 (14%)	B2 (16%)	
A1 (65%)	10,90[b]	11,00[b]	10,95
A2 (70%)	11,92[a]	9,72[c]	10,82
Average	11,41	10,36	
SE			0,08

Notes: Different superscripts indicate significantly different effects.

Organic Material Consumption (Kg/Head/Day)

The results showed a significant interaction (P<0.05) between Factor A (TDN) and Factor B (Protein) on Organic Material Consumption. Based on DMRT further test on the interaction between factor A and factor B, it was found that AIBI treatment was not significantly different (P>0.05) with AIB2 treatment. A1BI treatment is significantly different (P<0.05) with A2BI treatment. A2Bl treatment is significantly different (P<0.05) with A2B2 treatment. AIB2 treatment is significantly different (P<0.05) with A2B2 treatment.

Dry matter digestibility (%)

The results showed a significant interaction (P<0.05) between Factor A (TDN) and Factor B (Protein) on Dry matter Digestibility. Based on DMRT further test on the interaction between factor A and factor B, it was found that AIBI treatment was not significantly different (P>0.05) with AIB2 treatment. A2BI treatment is significantly different (P<0.05) with A2B2 treatment. AIBI treatment is significantly different (P<0,05) with A2B1 treatment. A1B2 treatment is significantly different (P<0,05) with A2B2 treatment.

Digestibility of Organic Matter (%)

The results showed that there was a significant interaction (P<0.05) between Factor A (TDN) and Factor B (Protein) on Organic Matter Digestibility. Based on the DMRT further test on the interaction between the two factors, it was found that the A1B1 treatment was not significantly different (P>0.05) with the A1B2 treatment. A2B1 treatment was significantly different (P<0.05) with A2B2 treatment. AIBI treatment is also significantly different (P<0.05) with

A2B1 treatment. A1B2 treatment was significantly different (P<0.05) with A2B2 treatment.

Crude Protein Digestibility (%)

The results showed that there was no significant interaction (P>0.05) between Factor A (TDN) and Factor B (Protein) on Crude Protein Digestibility.

Table 5: Average dry matter digestibility with different energy and protein balance (%).

Factor A (TDN)	Factor B (Protein)		Average
	B1 (14%)	B2 (16%)	
A1 (65%)	65,21[ab]	69,72[a]	67,47
A2 (70%)	72,84[a]	63,91[b]	68,37
Average	69,03	66,81	
SE			1,49

Notes: Different superscripts indicate significantly different effects (P<0.05).

Table 6: Average Digestibility of Organic Matter by Feeding Different Energy and Protein Balances (%).

Factor A (TDN)	Factor B (Protein)		Average
	B1 (14%)	B2 (16%)	
A1 (65%)	66,86[ab]	70,19[a]	68,52
A2 (70%)	74,19[a]	64,91[b]	69,55
Average	70,52	67,55	
SE			1,45

Notes: Different superscripts indicate significantly different effects (P<0.05).

Milk Production (Liter)

Based on the results of the study, there was a significant interaction (P<0.05) between Factor A (TDN) and Factor B (Protein) on Milk Production. Based on DMRT further test on the interaction between the two factors, it was found that AIBI treatment was not significantly different (P>0.05) with A1B2 treatment. A2B1 treatment was significantly different (P<0.05) with A2B2 treatment. A1B1 treatment is also significantly different (P<0.05) with A2B1 treatment. AIB2 treatment was not significantly different (P>0.05) with A2B2 treatment.

Dry Material Consumption (Kg/Head/Day)

In this study, feeding with 70% energy ratio and 14% protein showed the best dry matter consumption of 14,88 kg/head/day. The optimal dry matter consumption in the A2B1 treatment (14,88 kg/head/day) was due to the appropriate ratio of TDN and protein in the feed that met the needs of the livestock. In contrast, the lower dry matter consumption in the A2B2 treatment (13,22 kg/head/day) occurred because feed with high TDN and protein content made the animals feel full faster, reducing their appetite.

Livestock have biological mechanisms to regulate feed intake based on nutrient requirements. When feed is high in TDN and protein, hormonal signals such as leptin and ghrelin indicate that nutrient requirements are met, thus reducing hunger and feed intake. According to Church (1991), feeding feeds with too high TDN and protein content can cause health problems such as indigestion or other metabolic problems, which can make livestock feel uncomfortable and reduce appetite and feed consumption.

Table 7: Average Protein Digestibility by Feeding Different Energy and Protein Balances (%).

Factor A (TDN)	Factor B (Protein)		Average
	B1 (14%)	B2 (16%)	
A1 (65%)	68,30[b]	71,38[a]	69,84
A2 (70%)	75,24[a]	65,56[b]	70,40
Average	71,77	68,47	
SE			1,32

Notes: Different superscripts indicate significantly different effects (P<0.05).

Table 8: Average Milk Production with Different Energy and Protein Balances (kg/head/day).

Factor A (TDN)	Factor B (Protein)		Average
	B1 (14%)	B2 (16%)	
A1 (65%)	16,78[b]	18,59[ab]	17,68
A2 (70%)	20,57[a]	17,82[b]	19,19
Average	18,68	18,20	
SE			0,78

Note: Different superscripts indicate significantly different effects (P < 0.05).

Organic Material Consumption (Kg/Head/Day)

In this study, feeding with a ratio of 70% energy and 14% protein resulted in the best organic matter consumption of 13,41 kg/head/day. The optimal organic matter consumption in the A2BI treatment (13,41 kg/head/day) was due to the high dry matter consumption in the treatment. Conversely, the lower organic matter consumption in the A2B2 treatment (11,92 kg/head/day) was due to the low dry matter content in the treatment. The high and low consumption of organic matter is strongly influenced by the high and low consumption of dry matter. According to Astuti *et al.* (2009), organic matter consumption is closely related to dry matter consumption; the higher the dry matter consumption, the higher the organic matter consumption. Djita *et al.* (2019) also observed that the consumption level of organic matter in the ration increased along with the increase in dry matter consumption in the ration. This is because the nutrients contained in dry matter are also contained in organic matter, so the consumption of organic matter in the ration is highly dependent on dry matter consumption. According to Riyanto *et al.* (2020), this is reinforced by their research which shows a strong relationship between dry matter consumption and organic matter in livestock rations.

Dry matter digestibility (%)

In this study, feeding with a ratio of 70% energy and 14% protein resulted in an optimal dry matter digestibility of 69,18%. The best dry matter digestibility in the A2Bl treatment (69,18%) was due to the feed having a combination of 70% TDN and 14% protein, which is an appropriate and optimal ratio to support rumen microbial activity. This led to efficient fermentation and optimal nutrient utilization to increase dry matter digestibility.

Such a balanced diet helps to reduce excess ammonia production from deamination of unneeded protein, and allows more energy to be used for physiological and digestive processes (Havel, 2001). Widyobroto *et al*. (2007) explain that feed with high TDN content tends to produce greater microbial protein synthesis compared to low TDN feed. Haryanto (2012), added that synchronization or balance between the availability of energy and protein in the rumen can increase microbial activity and rumen microbial protein synthesis.

Organic matter digestibility (%)

In this study, feeding with a ratio of 70% energy and 14% protein produced the best organic matter digestibility of 71,29%. The optimal digestibility of organic matter in the A2BI treatment (71,29%) was caused by the high digestibility of dry matter in the treatment. An increase in dry matter digestibility contributes to an increase in organic matter digestibility, in accordance with the principle expressed by Raharjo *et al*. (2013). In addition, Fathul and Wajizah (2010) also stated that organic matter is part of dry matter, so an increase in dry matter will increase organic matter, and vice versa. The digestibility of organic matter reflects the availability of nutrients from feed. In this study, the digestibility oforganic matter was higher than the digestibility of dry matter because dry matter still contains ash, while organic matter does not contain ash. Therefore, materials without ash content are relatively easier to digest, as described by Dewi *et al*. (2012).

Crude Protein Digestibility (%)

In this study, feeding with a ratio of 70% energy and 14% protein produced the best crude protein digestibility of 72,25%. The optimal protein digestibility in the A2B1 treatment (72,25%) is due to the fact that cows are able to digest protein well on feed that has a combination of 70% TDN and 14% protein, which is sufficient for cattle needs.

The low protein digestibility in the A2B2 treatment (67,41%) was caused by feeding with high TDN and protein levels, which can have an impact on rumen microbes. An imbalance between TDN and protein can inhibit the growth and activity of microbes responsible for fermenting protein efficiently. Feeds with high protein content may produce excess ammonia from deamination of proteins that are not utilized by rumen microbes. Excess ammonia will be reabsorbed into the blood circulation and excreted as urea, indicating that the protein is not fully utilized by the animal's body.

Milk Production (Liters)

In this study, feeding with a ratio of 70% energy and 14% protein resulted in the best milk production of 19,98 liters. The optimal milk production in the A2BI treatment was due to the fact that the dairy cows received feed with energy and protein ratios that matched their needs, resulting in a higher supply of energy and amino acids for milk synthesis.

Meanwhile, the low milk production in the A1BI treatment was caused by inadequate feed to support milk production. The high energy content in feed can increase the energy supply that affects milk production, in accordance with the opinion of Legowo (2002) which states that energy in feed can affect milk production.

CONCLUSIONS AND RECOMMENDATIONS

The conclusion of this study is that feeding with the ratio of energy and protein at the level of Energy (TDN) 70% and Protein 14% (A2BI) in the ration showed optimal results. In this treatment, dry matter consumption (DMC) was 14,88 kg/head/day, organic matter consumption (OMC) was 13,41 kg/head/day, dry matter digestibility (DMD) reached 69,18%, organic matter digestibility (OMD) reached 71,29%, crude protein digestibility was 72,25%, and milk production was 19,98 liters/head/day. These results indicate that this ratio supports optimal conditions for dairy cows in terms of feed consumption, nutrient digestion, and milk production.

ACKNOWLEDGEMENTS

The current study was conducted successfully owing to the great contribution of my collage in terms of providing equipment, technical support, and relevant literature facilities.

NOVELTY STATEMENT

Energy and Protein in Balance already has standards in NRC for Dairy Cattle in Subtropical Countries. So, this study aims to observe these standards whether they can be applied in tropical countries.
For futhur studies need more resources.

AUTHOR'S CONTRIBUTIONS

FFY carried out the experimental data analysis and wrote all of manusricpt text. A and MZ was responsible for supported the funding and coordination of the study.

Conflict of Interest

The authors have declared no conflict of interest.

REFERENCES

Astuti A, Agus A, Budhi SPS (2009). Effect of using high quality feed supplement on consumption and nutrient digestibility of early lactation dairy cows.lactation. Livestock Bull., 33(2): 81-87. https://doi.org/10.21059/buletinpeternak.v33i2.120

Church DC (1991). Digestible Physiology and Ruminants. Vol I. Digestible Physiology 2ndEdition. 0 and B Inc. Oregon.

Despal, Permana CG, Safarina S, Tatra AJ (2011). Use of various sources of water soluble carbohydrates to improve flax leaf silage quality. Livestock Media. 34(2):69-76. https://doi.org/10.5398/medpet.2011.34.1.69

Dewi NK, Mukodiningsih SSutrisno CI (2012). Effect of fermentation combination of rice straw and com straw with water buffalo rumen contents on the digestibility of dry matter and organic matter in vitro. Anim. Agric. J., 1 (2): 134 - 140.

Djita M, Hadisutanto B, Penu CL (2019). Dry matter and Organic Matter Consumption Organic Matter Consumption of Male Bean Goats (Capra aegagrus hircus) with and without Shade. Shaded and Shade-less. PARTNER. 24(1): 896-904. https://doi.org/10.35726/jp.v24i1.345

Fathul F, Wajizah S (2009). Addition of mjcromineral Mn and Cu in rations. ration on sheep rumen biofermentation activity in vitro. JITV, 15(1) :9-15.

Gandhy A, Kumiawati SD (2018). Analysis of business development strategies cooperative milk production Bogor, West Java. Maksipreneur Journal: Management, Cooperatives, and Entrepreneurship, 8(1), 15-31. https://doi.org/10.30588/jmp.v8i1.376

Haryanto B (2012). The development of rumjnant nutrition research. Wartazoa., 22(4): I 69-177

Havel PJ. 2001. Peripheral Signal Conveying Metabolic Information to the Brain : Short Term and Long term Regulation of Food Intake and Energy Homeostatic. Experimental Biology and Medicine 226, 963-977.

Hermon (2009). Synchronization index of N-Protein and TON release in the rumen as a basis for ruminant ration formulation with local ingredients. zxGraduate Dissertation of Bogor Agricultural Institute. Bogor

Legowo AM (2002). Chemical, Physical and Mkrobiological Properties of Milk. Diktat Program Study Program of Livestock Product Technology.Faculty of Animal Husbandry, University of Di ponegoro University. Semarang

NRC (2001). Nutrient Requirement of Dairy Cattle. 8th Edition. National Academic of Science, Washington D.C.

Raharjo AWT, Suryapratama W, Widiyastuti T (2013). Effect of Field Grass - Concentrate on the Digestibility of Dry Matter and Organic Matter in Vitro. In Vitro. Sci. J. Arumal Husbandry, 1(3): 796- 803.

Ratnasari D, Atabany A, Purwanto BP, Salma LB (2019). Model growth model of Friesian Holstein (FH) dairy cows from birth to first calving at BBPTU-HPT Baturraden using the in BBPTU-HPT Baturraden dairy cows using logistic mathematics model.logistic mathematics model. J. Prod. Sci. Technol. Anim. Prod., 7(1): I8-21.

Rjyanto J, Widyawati SD, Surubya (2020). Effect of Different Ratio of Groats Protected and Unprotected Soybeans on Consumption, Digestibility, and Nutrient Value of Fat-Taj] ed Sheep Feed. Livestock and Anim. Res., 18(3): 240-245.

Widyobroto BP, Budhi SPS, Agus A (2007). Effect of Undegraded Protein and TON on Rumen Fermentation Kinetics and Mcrobial Protein Synthes in Cattle. Faculty of Animal Science UGM, Yogyakarta. J. Trop. Livestock Dev., 32 (3): 194-200.

Zahera, R., Purwanti, J., Evvyernie, D. 2022. Microbial Rumen Population, Fermentability, and Digestibility of Moringa Leaf Supplementation in Dairy Cow Ration Using in Vitro. IPB Journal., (20): 117-122.