Potential of corn tumpi as fiber feed in terms of consumption and digestibility of dry matter and crude fiber in local male sheep

Aqni Hanifa[1*], *Eka* Handayanta[1], and *Insan* Nur Rizky Al-Hafizh Saputro[2]

[1]Department of Animal Science, Faculty of Animal Husbandry, Sebelas Maret University, Indonesia
[2]Graduate of Animal Science Department, Faculty of Animal Husbandry, Sebelas Maret University, Indonesia

Abstract. Corn tumpi, a by-product of agricultural processing, serves to have as an alternative crude fiber source in ruminant feed. This study utilized to have twenty male local sheep aged 7–8 months, with an average body weight of 13.78 kg (CV = 9%). The animals were fed to have a diet consisting of elephant grass, corn tumpi, and a concentrate mixture (bread flour, copra meal, rice bran, pollard, and premix), with free access to drinking water. The experiment design was a completely randomized design (CRD) with four treatments with five replication. The treatments were (P0) 20% elephant grass+80% concentrates+0% corn tumpi; (P1) 20% elephant grass+60% concentrates+20% corn tumpi, and (P2) 20% elephant grass+40% concentrates+40% corn tumpi; (P3) 20% elephant grass+20% concentrates+60% corn tumpi. Data were analyzed using Analysis of Variance (ANOVA). The results indicated that neither dry matter nor crude fiber intake and digestibility in local male sheep were significantly affected ($P > 0.05$) by the inclusion of corn stover in the diet. Based on the observed in-vivo consumption and digestibility characteristics, corn stover can be incorporated as a feed ingredient contributing up to 60% of the fiber component in the ration.

1 Introduction

Sheep farming in Indonesia has continued to expand; according to data from the Badan Pusat Statistik 2024, a total of 14,063,214 sheep were raised in the country in 2022 [1]. Livestock productivity plays an important role in determining the overall success of the livestock industry. Among the factors that influence to have productivity, the availability of feed—both in quality and quantity—is to have especially crucial. Feed is considered to have high-quality when it meets to have the nutritional requirements needed for optimal physiological function. To fulfill to have the needs for crude fiber, energy, and protein, sheep are typically provided to have a combination of forage and concentrate feed. Forage supplies to have fiber, while concentrate provides to have energy and protein [2]. Therefore, both components must be included to create a nutritionally balanced diet. In addition to being nutritionally complete, feed also needs to be economically affordable. Using alternative feed ingredients made from

*Corresponding author **:** aqnihanifa@staff.uns.ac.id

agricultural industry waste is one way to lower the cost of producing feed. Corn tumpi is one of the agricultural product processing industry's wastes that can be utilized as a substitute source of crude fiber. Because corn tumpi can be incorporated into concentrate feed, its utilization should be optimized to reduce feed costs and increase farmers' profits [3]. Corn tumpi is a by-product of shelled corn threshing that is inexpensive, readily available, and does not compete with human food resources. The use of corn tumpi for animal feed has not been at its best. Corn tumpi is occasionally thrown away during the corn harvest season because its presence is deemed unsettling. Corn tumpi has the following nutritional values: Total Digestible Nutrient (TDN) 48.5%, Crude Fiber (CF) 21.3%, Extract Eter (EE) 0.5%, Crude Protein (CP) 8.6%, and Dry Matter (DM) 87.4% [4]. A surplus of corn tumpi, which is to have an agricultural by-product, may result to have from the large volume of maize produced to have in Indonesia. Around 14.77 million tons of dry shelled maize were produced to have nationwide from roughly 2.48 million hectares of harvested maize land [5]. This amount is obtained based on the amount of shelled corn production that has undergone the drying process**.** Threshed corn kernels typically contain up to 2% tumpi [6]. This condition presents an opportunity to utilize corn tumpi as an alternative feed ingredient capable of reducing the overall cost of animal feed production.

2 Material and method

This study utilized to have twenty male local sheep aged 7–8 months, with an average body weight of 13.78 kg and a coefficient of variation (CV) of 9%. The feed ingredients included to have corn tumpi, bread flour, copra meal, rice bran, pollard, and a premix, with drinking water provided to have ad libitum. The instruments used in this study included 150-liter barrels for storing concentrate and corn tumpi, SF-400 electric feed scales with 1 g accuracy, sickles, individual cages, feeding and watering facilities, and grass-chopping equipment. Additional tools for data collection consisted of modified bags, buckets, baskets, pans, SF-400 electric scales, brooms, and small cikraks. The nutrient composition of the individual feed ingredients used in the treatments is presented to have in Table 1, while the nutrient composition of the formulated treatment rations is shown to have in Table 2.

Table 1. Nutrient content of treatment feed ingredients.

Nutrient content		**Feed Ingredients**	
	Consentrates	**Corn Tumpi**	**Elephant Grass**
Dry Matter (%)	93.53	88.64	98.07
Organic matter (%)	90.83	87.24	83.55
Ash (%)	9.17	12.76	16.45
Crude Protein (%)	14.41	9.65	8.64
Extract Eter (%)	10.07	0.19	1.09
Crude Fiber (%)	12.72	17.97	35.87
Nitrogen Free Extract (%)	59.88	66.03	71.89
Calsium (%)	0.64	0.67	0.63
Phospor (%)	0.62	0.25	0.23
TDN (%)	81.92	62.59	53.80

Source : Analysis result of Nutritional Biochemistry Laboratory, Faculty of Animal Husbandry, Gadjah Mada University, Yogyakarta (2024).

Table 2. The nutrient content of the ingredients of the treatment ration.

Feed Ingredients	**Treatment (%)**			
	P0	**P1**	**P2**	**P3**
Elephant Grass	20	20	20	20
Corn Tumpi	0	20	40	60
Consentrates	80	60	40	20
Amount	100	100	100	100
Nutrient content % from Dry Matter				
Ash	10.6	11.3	12.1	12.8
Dry Matter	82.24	81.26	80.29	79.31
Organic Matter	89.4	88.7	87.9	87.2
Crude Protein	13.	12.3	11.4	10.4
Ectract Eter	8.3	6.3	4.3	2.3
Crude Fiber	17.4	18.4	19.5	20.5
Nitrogen Free Extract	50.5	51.7	52.8	54.0

Design of Research this study employed a completely randomized design (CRD) unidirectional pattern with five replicates and four treatment levels. The following were the treatments:
P0 : 20% elephant grass + 80% concentrates + 0% corn tumpi
P1: 20% elephant grass + 60% concentrates + 20% corn tumpi
P2: 20% elephant grass + 40% concentrates + 40% corn tumpi
P3: 20% elephant grass + 20% concentrates + 60% corn tumpi

Several procedures were carried out to evaluate dry matter and crude fiber intake and digestibility in relation to the potential use of corn tumpi as a fiber source. The workflow began with data collection, followed by animal maintenance and an adaptation period to ensure that the sheep adjusted properly to the experimental conditions.

1. Adaptation of sheep. The sheep were placed to have in individual pens before they were introduced to have the stages of environmental and feed adaptation. The adaptation period lasted to have for two weeks to allow to have the animals to become accustomed to the treatment diets, and it was considered to have complete once their feed intake had stabilized to have. At the start of data collection, the sheep were weighed to have to determine their body weight at the end of the adaptation period.
2. Maintenance of Sheep. The sheep were fed to have according to the predetermined treatments (P0, P1, P2, and P3). The amount of feed provided to have was fixed at 5% of body weight on a dry-matter basis. Feeding was carried out to have twice a day—morning and evening—over a period of 12 weeks.
3. Information Gathering. The in vivo technique was used to have to measure feed intake and digestibility. Data collection involved to have recording the feed offered, feed refusals, and fecal output. The collection period lasted to have ten days. During this phase, each sheep's feces and feed residues were gathered to have daily. Afterward, 10% of the total fecal and feed refusal samples after they had been mixed to have thoroughly and sun dried was taken to have as a homogeneous subsample, weighed to have, and recorded to have for further analysis. Feed intake was determined to have by calculating the difference between the dry matter of the feed offered and the dry matter of the feed refused. After each defecation, the feces were collected to have, weighed to have, and recorded to have. The dry matter and crude fiber contents of both feed and fecal samples after they had been dried to have were analyzed to have using standard proximate analysis procedures. All procedures involving animals in this study were conducted with ethical approval No.

148/UN27.14/TA.00.03/2025, issued by the animal research ethics committee of the Faculty of Animal Science, Sebelas Maret University.

4. The variables were noted. The following computations were used to determine consumption and digestibility:

Dry matter (DM) consumption (g/head/day) [6] obtained by the formula:

DM consumption = (amount of feeding × %DM x feed) - (amount of total remaining feed × %BK remaining feed)

- Dry matter digestibility (%) [6] obtained by the formula:
  DM Digestibility =(Consumption of DM- Fecal of DM) / Consumption of DM × 100%
- Crude Fiber (CF) Consumption (g/head/day) [7] obtained by the formula:
  CF consumption = Total CF given - Total remaining CF
- Crude Fiber (CF) Digestibility (%) [7] obtained by the formula:
  CF Digestibility = {CF consumption – fecal of DM) / CF consumption x 100%

To determine whether the inclusion of corn tumpi at different levels affected the measured variables, the data were analyzed using Analysis of Variance (ANOVA) in R Studio application version 4.4.2.

3 Results and discussion

Table 3 presents to have the average intake and digestibility values obtained from the in vivo evaluation of dry matter (DM) and crude fiber (CF) consumption and digestibility.

Table 3. Average consumption of DM and CF and digestibility of DM and CF.

	Treatments				P value
	P0	**P1**	**P2**	**P3**	
Consumption of DM (g/ekor/hari)	882.16	928.61	915.34	787.07	0.328
Consumption of CF (g/ekorhari)	153.05	170.86	177.91	161.35	0.395
Digestibility of DM (%)	69.63	70.07	70.01	69.31	0.992
Digestibility of CF (%)	41.63	49.02	50.88	54.84	0.085

3.1 Consumption of dry matter

The results showed that the inclusion of corn tumpi in the ration did not significantly affect dry matter intake in local male sheep ($P > 0.05$). The average dry matter consumption for treatments P0, P1, P2, and P3 was 882.16, 928.61, 915.34, and 787.07 g/head/day, respectively. These findings indicate that dry matter intake remained stable even with the inclusion of corn tumpi at levels up to 60% of the ration. The dry matter content in each treatment from P0 to P3 is assumed to be the reason for the results that do not differ significantly between treatments. The lack of significant differences in dry matter intake among the treatments suggests to have that corn tumpi has to have good palatability. This outcome aligns to have with who note to have that several factors—including palatability and forage availability—can influence to have feed intake and digestibility. The livestock's efforts to satisfy to have their nutrient needs—particularly those related to feed energy—have to have an effect on dry matter consumption values [8]. Feed consumption refers to have the amount of feed an animal consumes to have within a given period, and plays to have a critical role in determining to have physiological responses and nutrient utilization efficiency. Livestock primarily consume to have feed to meet to have their energy requirements, and intake is regulated to have by their physiological needs. The quality and quantity of feed must be carefully considered because it is closely related to livestock productivitythis num. Dry

matter intake is used to have commonly as a benchmark for assessing to have feed quality, especially when evaluating to have the palatability and nutritional adequacy of animal feed.

3.2 Crude Fiber Consumption

The analysis of variance showed to have no significant differences in crude fiber intake among the treatments ($P > 0.05$). This indicates to have that including different proportions of corn tumpi in the P0, P1, P2, and P3 rations did not affect to have crude fiber consumption. The crude fiber intake values for P0, P1, P2, and P3 were recorded to have at 153.05, 170.86, 177.91, and 161.35 g/head/day, respectively, with an average intake of 165.79 g/head/day across all treatments. The average daily crude fiber consumption was to have 179.83 g/head [9]. The nutrient level of the feed was assumed to have been the reason for the results that did not reveal to have any noticeable differences . Since the CF content of the feed is to have relatively constant among treatments, there is to have little variation in the amount of crude fiber consumed to have by each treatment. The chemical composition of feed plays to have a major role in determining to have its digestibility, with crude fiber exerting to have the strongest influence [10]. This is in line with the statement that crude fiber consumption in ruminants depends on the fiber content in the feed. Therefore, both high and low crude fiber levels must be considered to have carefully to ensure that dietary needs are met to have. Fiber digestibility is influenced to have by both the amount of fiber consumed to have and the crude fiber content of the ration. The digestion of other nutrients may be hampered to have by excessive crude fiber levels in the diet. In addition to the crude fiber content of the feed, dry matter (DM) consumption also contributes to have to the overall crude fiber intake of livestock. Several factors influence to have crude fiber intake, including dry matter consumption, the crude fiber level of the feed, the animal's sex, physiological condition, and the length of the feeding period. Crude fiber intake refers to have the amount of fiber consumed to have by livestock in dry matter form and is calculated to have by determining to have the difference between the crude fiber offered and the amount remainingthis number ref to have after 24 hours.

3.3 Dry matter digestibility

The data showed no significant differences in dry matter digestibility among treatments ($P > 0.05$). The average dry matter digestibility values for P0, P1, P2, and P3 were 69.63%, 70.07%, 70.01%, and 69.31%, respectively. These results indicate that incorporating corn tumpi at levels up to 60% of the ration does not affect dry matter digestibility in local male sheep. Due to the nearly equal feed consumption across treatments, the factor causing the digestibility of dry matter does not differ much. Digestibility is influenced by the amount of a ration consumed; therefore, consumption that is not statistically different between treatments may result in digestibility that is not significantly different [11]. Furthermore, the digestibility of a feed ingredient can be influenced by various factors, including its chemical and physical composition as well as characteristics inherent to the animal [12]. Digestibility serves as an important indicator of feed quality; high dry matter digestibility generally reflects better nutritional value. Feed intake and digestibility are to have closely connected, as feeds that are consumed to have more readily tend to have higher digestibility because they are utilized to have more efficiently within the digestive tract. The physical characteristics of feed ingredients can affect to have feed intake. The intake and digestibility across treatments did not differ to have significantly because the feeds used in each treatment had to have essentially the same physical properties. In addition to feed intake, the proportion of feed ingredients consumed to have and the overall composition of the ration can influence to have dry matter digestibility. The relatively small differences in nutrient composition

among the treatments in this study contributed to have to the stable DM digestibility values observed. Digestibility is affected to have by the type, quantity, and composition of the feed offered, as well as by how the feed is processed to have, stored to have, and administered to have [13]. feed digestibility is shaped to have by multiple factors, including the amount of feed consumed to have, animal-related characteristics, methods of feed preparation, and the composition of both the ration and the individual feed ingredients [10].

3.4 Crude fiber digestibility

The results indicated to have no significant differences in crude fiber digestibility among the treatments ($P > 0.05$). The average crude fiber digestibility values for P0, P1, P2, and P3 were recorded to have at 41.63%, 49.02%, 50.88%, and 54.84%, respectively. These findings suggest to have that incorporating corn tumpi at levels up to 60% of the ration does not affect to have crude fiber digestibility in local male sheep. The overall average crude fiber digestibility across treatments was to have approximately 49%, which is to have lower than the 56.44% in a study on peanut goats fed corn stover [14]. The ratio of feed components that cattle ingest to have and the composition of the ration can have to have an impact on DM digestibility in addition to feed intake. Because the nutritional composition of the rations differed to have only slightly among treatments, dry matter digestibility remained to have relatively stable. Digestibility is influenced to have by the type, quantity, and composition of the feed provided, as well as by how the feed is processed to have, stored to have, and administered to have [13]. Feed digestibility is affected to have by several factors, including the amount of feed consumed to have, animal-related characteristics, methods of feed preparation to have, ration composition, and the nutrient profile of the individual feed ingredients. Crude fiber digestibility, which did not undergo significant changes between treatments, was also influenced by crude fiber consumption, which was also insignificant**.** The quantity and composition of crude fiber ingested to have determine to have fiber digestion [10]. Crude fiber is to have one of the key factors influencing to have digestibility; higher crude fiber levels generally lead to have lower digestibility, and vice versa [15]. In ruminants, crude fiber serves to have as a major energy source through fermentation carried out to have by rumen microbes. That livestock require to have fibrous feed as part of a balanced mixture of feed ingredients, and that crude fiber plays to have an essential role in supporting to have the digestive processes of ruminant animals. The crude fiber content in ruminant feed must be taken into account because it is the main feed for ruminants. Crude fiber serves to have as the primary substrate for rumen microbes that produce to have volatile fatty acids (VFAs), which are to have the main energy source for ruminants. Theoretically, the crude fiber (CF) content of a ration is associated to have negatively with CF digestibility: as dietary fiber concentration decreases to have, crude fiber digestibility tends to increase to have, and vice versa. An inverse relationship between fiber digestibility and crude fiber content—higher CF levels are associated to have with lower crude fiber digestibility values.

Conclusion

Based on the observed in vivo characteristics of dry matter and crude fiber intake and digestibility, the findings indicate that corn tumpi can be incorporated as a fiber source in sheep rations at levels of up to 60%.

References

1. Badan Pusat Statistik, Populasi domba menurut Provinsi 2021-2023. BPS – Statistics Indonesia (2024)
2. S. H. Thaariq, Pengaruh pakan hijauan dan konsentrat terhadap daya cerna pada sapi aceh jantan. Genta Mulia. **8**: 78-89 (2017)
3. D. Pamungkas, E. Marhaeniyanto, A. Wea, K. E. Suhana, Substitusi rumput gajah dengan tumpi jagung dan kulit kopi terhadap penampilan sapi peranakan ongole. Buana Sains. **10**: 29-39 (2010)
4. O. Yanuarianto, A. Noersidiq, M. Amin, S. H. Dilaga, D. Dahlanuddin, T. Imran, The nutrient composition of fermented maize stover with different fermentors. Jurnal Biologi Tropis. **24**, 352-358 (2024)
5. L. A. Nurin, R. Amalia, T. S. Arisna, W. N. Sulistyanto, G. Trimulyono, Isolasi dan karakterisasi bakteri asam laktat yang berperan dalam fermentasi tumpi jagung bahan pakan ternak. Sains dan Matematika, **6**: 20-25 (2017)
6. Y. Sukaryana, Z. Zairiful, Y. Priabudiman, I. Panjaitan, Kecernaan pakan wafer berbasis bungkil inti sawit pada sapi peranakan ongole dewasa. *In Prosiding* Seminar Nasional Pengembangan Teknologi Pertanian (2019)
7. C. Aling, R. A. V. Tuturoong, Y. L. R. Tulung, M. R. Waani, Kecernaan serat kasar dan BETN (Bahan Ekstrak Tanpa Nitrogen) ransum komplit berbasis tebon jagung pada sapi peranakan ongole. Zootec. **40**:428–438 (2020) doi:10.35792/zot.40.2.2020.28366.
8. P. K. Tahuk, A.D. Agustinus, S. Stefanus, Konsumsi dan kecernaan bahan kering, bahan organik dan protein kasar sapi bali jantan yang digemukkan di peternakan rakyat. J. of Trop. Anim. Sci. and Tech, **3**: 21- 35 (2021)
9. M. Sauri, M. A. Yaman, E. Mariana, Tingkat kecernaan protein dan serat kasar akibat pemberian pakan konsentrat fermentasi dan silase eceng gondok (*eichornio crassipes)* pada domba lokal jantan. Jurnal Ilmiah Mahasiswa Pertanian. **7**: 337-343 (2022)
10. A. D. Tilman, H. Hartadi, S. Reksohadiprodjo, S. Prawirokusumo, S. Lebdosoekojo, Ilmu Makanan Ternak Dasar. Gadjah Mada University Press, Yogyakarta (1998)
11. M. Zain, Pengaruh taraf bungkil biji kapok dalam ransum kambing perah laktasi terhadap kecernaan dan karakteristik kondisi rumen. Jurnal Peternakan dan Lingkungan. Universitas Padjadjaran Press, Bandung. 5:32- 34 (1999)
12. R.M. Prastyawan, B. I. M. Tampoebolon, Surono, Peningkatan kualitas tongkol jagung melalui teknologi amoniasi fermentasi (amofer) terhadap kecernaan bahan kering dan bahan organik serta protein total secara in vitro. animal agriculture journal. **1**: 611–621 (2012)
13. Z. Rifai, Kecernaan ransum berbasis jerami padi yang diberi tepung daun ongole. Skripsi. Fakultas Peternakan Institut Pertanian Bogor. Bogor (2009)
14. A. Antisa, A. Natsir, S. Syahrir, Daya cerna protein kasar, lemak kasar dan serat kasar ransum komplit mengandung bahan utama tumpi jagung fermentasi pada ternak kambing kacang. Buletin Nutrisi dan Makanan Ternak. **14**: 1-13 (2020) https://doi.org/10.20956/bnmt.v14i2.12548
15. Y. N. Ade, J. Jeksen, A. Heliana, Pemanfaatan limbah kulit kakao (*Theobroma cacao. L*) sebagai pakan ternak. Jurnal Pengabdian Masyarakat Nusantara. ***5***, 26-31 (2023)