Advances in Biological Sciences Research, volume 21
Proceedings of the 6th International Seminar of Animal Nutrition and Feed Science (ISANFS 2021)

The Effect of Using Water Spinach on the Physical Quality of Pellets

Himmatul Hasanah[1], Joelal Achmadi[2], Eko Pangestu[2], Muhsin Al Anas[3], and Ali Agus[3,*]

[1] *Department of Biology Education, Faculty of Math and Science, Yogyakarta State University, Yogyakarta, Indonesia*
[2] *Departement of Animal Science, Faculty of Animal and Agricultural Sciences, Diponegoro University, Semarang, Central Java, Indonesia*
[3] *Department of Animal Nutrition and Feed Science, Faculty of Animal Science, Universitas Gadjah Mada, Yogyakarta, Indonesia 55281*
**Corresponding author. Email: aliagus@ugm.ac.id*

ABSTRACT
The high fiber content in forage causes nutrients challenging to digest. Pellet technology breaks down the cell wall and increases the soluble fiber fraction. This study aims to determine the effect of using water spinach on the durability and hardness of pellets. The study was designed using a completely randomized design with four treatments consisting of T1: control; T2: 20% water spinach; T3: 40% water spinach and T4: 60% water spinach. Data were analyzed of variance and followed by Duncan Multiple Range Test. The results showed that the use of 60% water spinach significantly ($P<0.05$) decreased the durability and hardness of pellets. In conclusion, 30% of water spinach can be used as a source of forage fiber in pellets with the same quality as the control.

Keywords: *water spinach, physical quality, pellet*

1. INTRODUCTION

Forage is the main feed for ruminants besides concentrate. The high fiber content of forage makes forage difficult to digest. In addition, the use of fresh forage as animal feed is difficult to store for a long time because it is very susceptible to mold. Therefore, alternative forage feeds with high nutrient content are needed and processed to utilize nutrients to become more optimal and durable.

Water spinach (*Ipomoea aquatica*) is one type of forage that grows in Indonesia. According to Statistics Indonesia [1], water spinach production in Indonesia reaches 276,976 tons, with around 47,805 ha. Besides its abundant production, the nutrient content of water spinach can be used for animal feed. Water spinach contains crude protein reaching 5.18-24.60%, fiber 13.00-17.67%, dry matter 10.30%, and organic matter 87.60% [2]. In addition, water spinach is also high in minerals and amino acids [3].

Pellet technology can be used for forage preservation, reducing fiber content, and binding nutrients together. Pellets can break down cell walls and increase the soluble fiber fraction. Pellets can reduce fiber content (Neutral detergent fiber (NDF), Acid detergent fiber (ADF), acid detergent lignin (ADL), cellulose), and anti-nutritional content and does not affect reducing the protein content compared to unpelleted feed [4]. Pellet quality can be judged from durability and hardness. Pellet quality is affected by feed nutritional composition, ingredient particle size, conditioning temperature and time, and feed moisture [5,6]. This study aimed to determine the effect of using water spinach as a substitute for *Pennisetum purpureum* cv. Mott on the quality of pellet durability and hardness.

Table 1. Nutrient content of feed ingredients

Parameters (%)	Pennisetum purpureum cv. Mott	Concentrate	Water spinach	Soybean meal
Dry matter	92.93	88.87	89.42	89.15
Organic matter	83.43	89.77	84.60	92.40
Crude fiber	31.49	17.59	21.62	5.10
Crude protein	6.70	12.60	10.65	48.54
Extract ether	1.35	2.66	1.86	1.30
Ash	16.57	10.23	15.40	7.60
NFE	43.89	56.92	50.47	37.46
TDN	47.16	61.85	54.28	93.71
Hemicellulose	21.18	28.48	27.24	-
Cellulose	30.70	25.35	26.88	-
Lignin	12.67	11.47	12.22	-

NFE: Nitrogen-free extract; TDN: Total digestible nutrient

2. MATERIALS AND METHOD

This research was conducted at the Department of Animal Nutrition and Feed Science, Faculty of Animal Science, Universitas Gadjah Mada, Yogyakarta, Indonesia.

2.1. Feed Formulation and Processing

The pellet feed production with water spinach consisted of T1: control or without water spinach; T2: 20% water spinach; T3: 40% of water spinach, and T4: 60% of water spinach. The study was designed using a completely randomized design, and each treatment consisted of 5 replications. Nutrient content of feed ingredients was analyzed proximately before and after pelleting. After analyzing the chemical composition, a feed formulation was carried out based on the NRC [7]. The nutrient content of feed ingredients and pelleted feed formulation was shown in Table 1 and Table 2.

The pelleting process was carried out by reducing the size of the feed material using a 3 mm hammer mill. The feed ingredients are then mixed with molasses as an adhesive by spraying. After mixing, molasses is heated at 75-80ºC for 15 minutes. The water content in the mixture is made from 16-18% at a temperature of 60-65ºC. The mixture is then milled and pelletized using a 6 mm screen. The pellets were aerated and then analyzed for durability and hardness.

2.2. Pellet Durability and Hardness Assessment

Pellet durability was measured using a Pfost Tumbling box [8]. A sample of 500 g of intact pellets (without dust) was placed in a tumbling box. After tumbling for 10 min at 50 rpm in a dust-tight enclosure box, the sample was removed and sieved. The durability value was calculated by dividing the weight of the intact pellet after tumbling by the initial weight of the sample (500 g) multiplied by 100.

Table 2. Formulation and nutrient content of the pelleted feed

Feed	T1	T2	T3	T4
Formulation (%)				
P. purpureum cv. Mott	60	40	20	0
Water spinach	0	20	40	60
concentrate	25	28	30	33
Soybean meal	15	12	10	7
Total	100	100	100	100
Nutrient composition (%)*				
Dry matter	90.74	90.39	90.13	88.08
Organic matter	86.27	87.91	89.94	89.23
Crude protein	13.72	14.36	15.06	15.04
Extract ether	2.14	2.02	1.87	2.18
Crude fiber	21.43	22.03	21.29	20.97
Ash	13.73	12.09	10.06	10.77
Nitrogen-free extract	48.97	49.51	51.72	51.04
Total digestible nutrient	57.27	58.15	59.95	60.06
Hemicellulose	19.77	22.86	24.04	26.02
Cellulose	18.60	23.83	28.15	31.23
Lignin	12.48	10.55	11.10	11.77

T1: control; T2: + 20% of water spinach; T3: + 40% of water spinach; T4: + 60% of water spinach; *: Proximate analysis

Pellet hardness was measured using a manually operated "Kahl" hardness tester [9]. Measurements are made by pressing the pellet until it cracks. The hardness value is obtained based on the scale on the tool in kilograms with a sample size of 12-20 pieces.

2.3. Statistical Analysis

The data obtained were statistically analyzed using analysis of variance, followed by Duncan Multiple Range Test (DMRT) to separate among means.

3. RESULT AND DISCUSSION

3.1. The Effect of Using Water Spinach Levels on Pellets Durability

The effect of using water spinach on the durability of the pellets is shown in Figure 1.

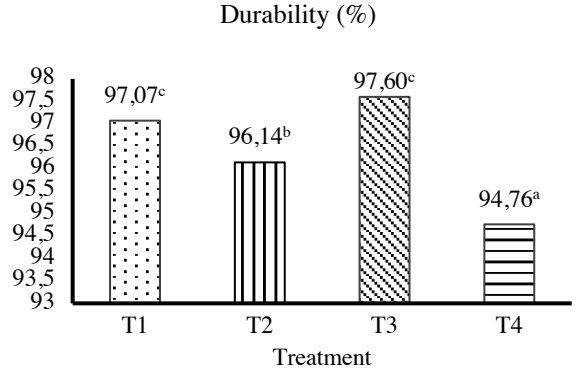

Figure 1. The effect of using water spinach on the physical quality of the pellets.

The use of 60% water spinach was significant ($P<0.05$), causing the lowest pellet durability value. The durability values of T1 and T3 pellets were not significantly different but were higher than T2. Pellet durability is the number of intact pellets after undergoing mechanical stirring. This parameter indicates the pellet's ability to withstand friction during storage and transportation. Pellets with a high level of durability indicate good pellet quality because the level of abrasion is low. Therefore the possibility of losing feed nutrients is slight. Pellets made from different energy crops and cereal straws have durability values ranging from 95.91% to 97.31% [10]. Pellet durability values in the study ranged from 94.76% to 97.60%. These results are still under the minimum pellet durability index's average value of 80% [11].

The pellet ingredient characteristics influence the durability value. High-fiber feedstuffs are difficult to agglomerate pellets, causing low durability [12,13]. The water-soluble fiber content increases the viscosity, thereby increasing the structural integrity and agglomeration of the pellets [14,15]. Increasing the viscosity and integrity of the pellets increases the durability value. The lower the cellulose (fiber) value in the material will increase the value of durability [14,16].

Pennisetum purpureum cv. Mott has a higher cellulose value than water spinach (Table 1), but if we look at the cellulose value in the T1 ration is the lowest (Table 2), which causes the durability value of pellet feed made from *Pennisetum purpureum* cv. Mott is highest. The cellulose content in the ratio, which tends to be lower, increases the durability value. Sources of water-soluble fiber increase the viscosity, in contrast to sources of fiber that are not soluble in water [14]. The contribution of forage and its classification as a source of high fiber may cause differences in pellet characteristics. Sources of arabinoxylan and pectin fibers increase the viscosity, thereby increasing the integrity of the pellet structure and feed agglomeration, increasing the hardness and durability of the pellets [17,18].

3.2. The Effect of Water Spinach Levels on Pellets Hardness

The effect of water spinach on the hardness of the pellets is shown in Figure 2.

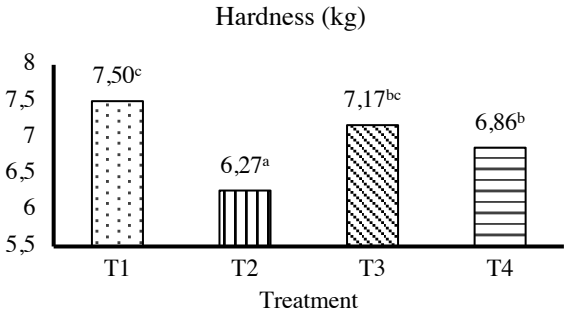

Figure 2. The effect of using water spinach on the physical quality of the pellets

The use of 60% water spinach was significant ($P<0.05$), causing the lowest T2 pellet hardness value. Pellets T1 and T3 have hardness values that are not significantly different. Meanwhile, the hardness value of T4 pellets was not different from T3, although it was lower than T1. The use of *Sargassum sp*. as a source of amylase, amylopectin, and cellulose reduces rabbit feed pellets' hardness [19].

Hardness or pellet hardness is an essential parameter of pellet quality, especially during transportation [20]. These conditions will undoubtedly affect nutrient consumption and relate to productivity in livestock. Pellet hardness is measured to indicate physical integrity or to ensure pellets are not too hard for target livestock. The hardness value of pellet packs with 6-8 mm is 6.5 kg [20]. Although the hardness value on pellets treated with water spinach was 6.27-7.50 kg, this value was still normal. The usual range of hardness values is 6.13-7.75 kg [21].

Pellet hardness values are influenced by several factors such as variations in pellet length and diameter, the presence of pellet cracks, compression received by the feed material during the manufacturing process, and the chemical composition of the material [6]. Fiber content such as cellulose, pectin, and amylopectin also affects pellets' hardness value. These materials will form gelatin, thus forming aggregations or carbon bonds to the chemical content of the material, thus forming a semi-crystalline part and increasing the strength of the pellet [14,16,22]. The pellet strength was increased when the main hemicellulose contained was xylan [23].

4. CONCLUSION

The use of 60% water spinach decreased the durability and hardness of the pellets, although still within the normal range. The use of 30% water spinach is recommended as a source of forage fiber in pellets with the same quality as the control.

REFERENCES

[1] Statistic Indonesia, "Statistical Yearbook of Indonesia", BPS-Statistics Indonesia Dicetak, Jakarta (2017).

[2] K.J. Umar, L.G. Hassan, S.M. Dangoggo, and M.J. Ladan, J. Appl. Sci., 7, 803–809 (2007).

[3] M.M. Ndamitso, M.B. Etsuyankpa, J.O. Jacob, J.T. Mathew, E.Y. Shaba, and K.C. Olisedeme, Acad. Res. Int., 6, 1–8 (2015).

[4] D.K. Oyaniran, V.O.A. Ojo, R.Y. Aderinboy, B.A. Bakare, and J.A. Olanite, Livest. Res. Rural Dev., 30, Article 75 (2018).

[5] R. Yasothai, Int. J. Sci. Environtment, 7, 1361–1365 (2018).

[6] K. Muramatsu, A. Massuquetto, F. Dahlke, and A. Maiorka, J. Agric. Sci. Technol. A, 5, 717–722 (2015).

[7] National Research Council, "Nutrient Requirements of Small Ruminants", NAS-NRC, Washington DC (2007).

[8] ASAE, "Cubes, Pellets, and Crumbles: Definitions and Methods for Determining Density, Durability, and Moisture Content. ASAE Standard S269.4.", American Society of Agricultural and Biological Engineers, St. Joseph, MI, (1997).

[9] J.F. Wood, Anim. Feed Sci. Technol., 18, 1–17 (1987).

[10] J.P. Carroll and J. Finnan, Biosyst. Eng., 112, 151–159 (2012).

[11] W.A. Dozier, J. Feed Int., 52, 40–42 (2001).

[12] J.L. Briggs, D.E. Maier, B.A. Watkins, and K.C. Behnke, Poult. Sci., 78, 1464–1471 (1999).

[13] W.B. Cavalcanti and K.C. Behnke, Cereal Chem., 82, 455–461 (2005).

[14] M.T. van V Thomas and A.F.B. van deer Poel, Anim. Feed Technol., 70, 59–78 (1998).

[15] R.E. Loar ii and A. Corzo, Worlds. Poult. Sci. J., 67, 19–28 (2011).

[16] J.Ø. Hansen and T. Storebakken, Aquaculture, 272, 458–465 (2007).

[17] M.E.F. Schooneveld-Bergmans, M.J.W. Dignum, J.H. Grabber, G. Beldman, and A.G.J. Voragen, Carbohydr. Polym., 38, 309–317 (1999).

[18] J. Rosicka-Kaczmarek, A. Komisarczyk, E. Nebesny, and B. Makowski, Eur. Food Res. Technol., 242, 295–303 (2016).

[19] A.R. Majiid, S. Mukodiningsih, and S. Sumarsih, J. Sain Peternak. Indones., 15, 360–366 (2020).

[20] T. Widiyastuti, C.H. Prayitno, and Munasik, Anim. Prod., 6, 43–48 (2004).

[21] R.S. Ismi, R.I. Pujaningsih, and S. Sumarsih, J. Ilm. Peternak. Terpadu, 5, 58–63 (2017).

[22] L.G. Tabil, S. Sokhansanj, and R.T. Tyler, Can. Agric. Eng., 39, 17–23 (1997).

[23] S. Frodeson, P. Lindén, G. Henriksson, and J. Berghel, Appl. Sci., 9, 4302 (2019).