Physical and Organoleptic Quality of Pellet with Different Tubers Type as Binder

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ABSTRACT

The research was conducted to determine the physical and organoleptic quality of pellets using different tubers (taro, potato, and sweet potato) as binder. Pellets were produced using double crane small flat die pelletizer and without instrument of conditioning. Pellet ingredients consisted of corn (16.89-17.38%), soy bean meal (9.47-10.08%), copra meal (5.63-5.79%), cassava leaves meal (45.86-45.90%), molasses (2.75%), limestone (3.00%), and salt (0.75%). The pellet ingredients and binders were formulated to produce three type of pellets with the same crude protein and energy level. Samples of pellets were tested for their hardness, Pellet Durability Index (PDI), texture, color, and odor. Pellets using taro binder was higher (95.57%) on PDI than potato (94.87%) and sweet potato (94.67%). Texture, color, and odor of pellets showed no difference between treatments. It could be concluded that organoleptic qualities of pellets were similar, while taro showed best physical quality for pellet binder.

Keywords: Binder, Organoleptic, Pellets, Physical, Quality, Tuber

INTRODUCTION

Changes in physical quality of pellets can lead to decreased livestock productivity because broken pellets will form fines pellets that are less favored by livestock, thus affecting livestock consumption. Pellet binders are used to provide more hardness and stronger pellets, and reduce the risk of broken pellets.

One type of binder is pregelatinization of starch. Pregelatinized starch is starch that has been treated gelatinization. The starch is easily obtained in various regions in Indonesia that is in the form of tubers. Different tubers have different starch content, while the binder's quality is influenced by starch content.

Types of tubers used in this research are taro, potatoes, and sweet potato. Taro is potential as pellet binder because of its high starch content and low amylose content, so it is possible to produce pellets with good physical quality. Kaushal et al. (2011) found that taro flour contains 75.19% starch, 2.51% amylose and 72.68% amylopectin (% DM). Potatoes have high starch content and starch from potatoes produce pellets with better physical quality than cassava starch. Kim and Kim (2014) obtained potato flour contains 69.8% of starch content and 18.6% of amylase content (% DM). The results of Sit et al. (2013) and Rocha et al. (2008) showed that potato starch has larger granular size and is more widely distributed than taro starch and sweet potato starch.

Sweet potatoes have high starch content and Indonesia is famous for its sweet potato production. Sweet potato flour contains 49% starch and 18.6% amylose (% DM) (Senanayake et al., 2013). This research aimed to determine the best type of tuber as a binder by studying the physical and organoleptic qualities of the pellets.

MATERIALS AND METHODS

The research was conducted at the Laboratory of Animal Feed Technology, Department of Animal Feed Nutrition, Faculty of Animal Science UGM. Physical quality analysis of pellet was conducted at PT. Japfa Comfeed Indonesia, Medan.

The materials of the experiment are potatoes (fresh), taro (fresh), sweet potatoes (fresh), corn, soy bean meal, cassava leaves (fresh), copra meal, molasses, limestone, salt, and reagent was used for proximate analysis

Preparation of pellets production

Producing tuber flour and cassava leaf meal. Production of tuber flour was conducted through the process of grating, drying, and grinding, whiles the process of producing cassava leaves meal only through drying and grinding. Drying process was carried out for four days by the help of the sunlight. The grinding process used a hammer mill. The grated taro was soaked for 20 minutes with salt solution, and then rinsed with running water.

Grinding of raw materials. Copra meal, soy bean meal, and limestone were grinded using a hammer mill.

Formulation of rations

The rations were formulated as rations for fattening rabbits (17.01% crude protein and 2789 kcal / kg energy (DM)) (Cheeke, 2005). The feed compositions of the three types of pellets are presented in Table 1.

Table 1. Pellet composition with taro, potato, and sweet potato as binder

Feed composition	Binder		
	Taro	Potato	Sweet potato
Corn (% DM)	17,01	17,38	16,89
Soy bean meal (% DM)	9,93	9,47	10,08
Cassava leaves meal (% DM)	45,89	45,86	45,9
Copra meal (% DM)	5,67	5,79	5,63
Molasses (% DM)	2,75	2,75	2,75
Limestone (% DM)	3,00	3,00	3,00
Salt (% DM)	0,75	0,75	0,75
Taro (% DM)	15,00	-	-
Potato (% DM)	-	15,00	-
Sweet potato (% DM)	-	-	15,00
Total	100	100	100

1) Corn, SBM, and molasses use CP values according to Hartadi et al. (2005) and its metabolic energy according to Kellems and Church (2010)
2) Copra meal uses CP value and metabolic energy according to Hartadi et al. (2005)
3) Cassava leaves meal use CP value according to Hartadi et al. (2005) and its metabolic energy according to Safwat et al. (2005) cit. Agus (2008)
4) Taro and sweet potatoes use CP values according to Paramita and Mulwinda (2012), potatoes use CP content according to Kellems and Church (2010), and the metabolic energy of the three tuber types uses the estimated metabolic energy value of cassava according to Mora et al. (2014)
5) The CP value and metabolic energy of salt and limestone are considered zero.

Each type of rations formulation in Table 1 was added water before the ration was fed into the pellet machine. The metabolic energy and nutrient content of the three types of pellets (after additions of water) are presented in Table 2.

Table 2. The content of metabolic energy and nutrient of rations

Nutrients	*Binder*		
	Taro	Potato	Sweet potato
Metabolizable Energy (kcal/kg DM)	2789,00	2789,00	2789,00
Dry matter (%)	19,51	19,51	19,51
Crude protein (% DM)	17,01	17,01	17,01
Crude fiber (% DM)	12,90	13,13	13,38
Crude lipid (% DM)	4,98	4,95	5,00
Fosfor (% DM)	0,28	0,35	0,28

The three types of rations in Table 1 were added with different amounts of water so as to have the same water content when fed to the pellet machine. The amount of water added to the ration with binder of taro, potato, and sweet potato was respectively 120, 121, and 121 (g / kg rations).

Mixing and pelleting

The mixing process was done after each material was weighed. After mixing, the homogenous material was fed into the pelletizer and resulted about 0.7 cm to 1.2 cm length of pellets, and then immediately dried.

Drying and packing of pellets

Pellets were dried using a simple oven. The drying temperature was about 38°C and pellets were dried for 13 hours. The dried pellets were then immediately packed in clear plastic and sealed tightly with a sealer. Pellets were analyzed for their physical and organoleptic qualities.

Physical quality analysis

Physical quality analysis comprised of durability and hardness with method as follows:
Durability test (Pellet durability index or PDI) used Holmen method (Thomas et al., 1996)

$$PDI = \frac{\text{Pellets weight after impact/collision}}{\text{Pellets weight fed into test instrument}} \times 100\%$$

Hardness test method used Kahl method (Thomas et al., 1996).

Organoleptic quality analysis

Organoleptic analysis comprised of color, texture, and odor by 15 respondents.

Data analysis

Data of hardness, PDI, texture, color, and odor were analyzed descriptively.

RESULTS AND DISCUSSION

Pellet physical quality

Results of pellets physical quality analysis with taro, potatoes, and sweet potatoes as binders are presented in Table 4.

Table 4. Physical quality of pellets with binder of taro, potato, and sweet potato

Test	*Binder*		
	Taro	Potato	Sweet potato
PDI (%)	95,57	94,87	94,67
Hardness (kg)	11,11	10,78	10,44

Pellet durability index. Higher PDI indicates that the pellets are more impact resistant. The PDI average of pellet with binder of taro, potato, and sweet potato are 95.57%, 94.87% and 94.67%, respectively. The PDI of the three types of pellets are likely to be affected by the nutrients of the binder used. The effect of starch on PDI of pellet is consistent with Sorensen et al. (2010) that different starch sources resulted in different physical qualities of pellet, which is pregelatinization of potato starch produced the highest *Holmen durability* (79%) and wheat starch produced the lowest *Holmen durability* (44%).

The starch content of taro, potato, and sweet potato flour were 75.19%, 69.8%, and 49% (DM), respectively (Misra and Kulshrestha, 2003; Senanayake et al., 2013; Alcantara et al., 2015). Starch as feed ingredient can generally improve the physical quality of pellets (Loar and Corzo, 2010).

The value of PDI with taro binder that was higher than potatoes and sweet potatoes is probably influenced by the amylose content of the binders. Amylose content of taro, potato and sweet potato flour are 2.51%, 18.6%, and 18.6% (DM), respectively (Misra and Kulshrestha, 2003; Kaushal et al., 2011; Senanayake et al., 2013).

Pellet hardness. Hardness of pellet is also called pellet resistance test to pressure (crushing) (Martens, 2010). The result of hardness of pellet with taro, potato and sweet potato binder were 11.11 kg, 10.78 kg and 10.44 kg, respectively. The most influential nutrients to pellet hardness are starch, since tuber binders are mostly composed of starch. Kellems and Church (2010) state that the content of CP and tuber fibers is low.

Pellets with taro binder have higher hardness than with potato binder, and pellets with potato binder have higher hardness than with sweet potato binder. This can be due to the starch content of the three types of binders. The starch content of taro, potato, and sweet potato flour are 75.19%, 69.8%, and 49% (DM), respectively (Misra and Kulshrestha, 2003; Senanayake et al., 2013; Alcantara et al., 2015). Binder from tubers may produce pellets with a fairly good level of hardness from the side of biological value of livestock and has sufficient level of hardness to avoid excessive production of fines during transportation or handling. Results of pellet hardness tests with taro, potato, and sweet potato binder ranged from 10.33 kg to 11.33 kg, while Martens (2010) stated that the minimum hardness value of 8 kg is important to avoid excessive production of fines during handling and transportation of pellets, especially when using automatic feeding tools.

Organoleptic quality

Pond et al. (2005) states that the appearance, odor, taste, texture, temperature, and other organoleptic senses of feed affect its palatability. Organoleptic quality analysis is based on responses from respondents. The results of organoleptic quality test are presented in Table 5.

Table 5. Pellet organoleptic quality analysis with taro, potato, and sweet potato as binder (Number of respondents)

Indicators	*Binder*		
	Taro	Potato	Sweet potato
Color			
Dark green	11	11	7
Green	3	3	4
Brown	1	1	3
Dark brown	0	0	1
Texture			
Fine	4	4	0
Somewhat fine	10	7	7
Somewhat rough	1	4	6
Rough	0	0	1
Odor			
Fresh	15	14	14
Musty	0	0	0
Fishy	0	0	0
Sweet	0	1	1

The results of organoleptic quality analysis in Table 5 show that pellets with taro, potato, and sweet potato binders have slightly different color, since the dominant respondents stated that the three pellets are dark green.

Organolepetic quality analysis results also show that the pellet color with sweet potato binder is browner than the other two pellets. This is probably related to the deficient gelatinization process in pellets using sweet potato binders (when compared to pellets with taro and potato binders). Gelatinization acts as a coating, so pellets with sweet potato binders are easier to react with air around when compared to the other two pellets.

Based on the results of the texture analysis, it is known that in general, the pellets with taro, potato, and sweet potato binders have texture that is not so different, that the texture is somewhat fine on all the three. The same is also obtained by Siswani and Maryanto (2014), pellets that use 10% tapioca flour as binder and pellets using 10% wheat flour as binder have fibrous texture on both, and did not report texture differences in both pellets. This may indicate that binders of different tuber types may not be as influential on the pellet texture produced.

The results of organoleptic quality analysis show that pellets with taro, potato, and sweet potato binders have no different odor that is fresh odor on all the three. The same is also shown by the results of Siswani and Maryanto (2014) research that pellets using 10% tapioca flour and 10% wheat flour as a binder have strong odor on both and there is no report of flavor difference from both types of pellets. This may indicate that binders of different types of tubers may not have an effect on the pellet odor.

Fresh odor in all three types of pellets indicates that all three types of pellets observed are in good condition during organoleptic quality analysis. Cruz (1996) stated that newly produced feed has pleasing pellet odor (agreeable odor), while the old stored pellet has faint odor. In addition, pellets odor with potato and sweet potato binder is sweeter than taro. This is probably related to the smell of the binder, because it is known that the odor of potato and sweet potato binder is sweeter than the taro binder.

CONCLUSION

It could be concluded that organoleptic qualities of pellet were similar, while taro showed best physical quality for pellet binder.

REFERENCES

Alcantara, R. M., W. A. Hurtada. dan E. I. Dizon. 2013. The nutritional value and phytochemical components of taro (*Colocasia esculenta, l. schott*) powder and its selected processed foods. J Nutr Food Sci 207: 1-7

Cheeke, P. R. 2005. Aplied animal Nutrition Feeds and Feeding. 3th ed. Pearson, United States of America

Cruz, P. S. 1996. Feed quality problems and management strategies. Proceedings of the nationanl seminar-Workshop on Fish Nutrition and Feeds. pp: 64-73

Hartadi, H., S. Reksohadiprodjo dan A. D. Tillman. 2005. Tabel Komposisi Pakan untuk Indonesia. 2th ed. Gadjah Mada University Press, Yogyakarta

Kellems, R. O. dan D.C. Church. 2010. Livestock Feeds and Feeding. Pearson, United States of America

Loar II, R.E. dan A. Corzo. 2010. Effects of feed formulation on feed manufacturing and pellet quality characteristics of poultry diets. J. World's Poultry Science. 67:19-28

Martens, L. 2010. Feeding system for intensive production. In: Nutrition of The Rabbit/ Edited by Carlos de Blas and Julian Wiseman, 2nd Ed. C. de Blas dan J. Wiseman (eds.). CAB International 2010, CPI Antony Rowe Ltd, UK

Misra, A dan K. Kulshrestha. 2003. Effect of storage on nutritional value of potato flour made from three potato varieties. Plants Foods for Human Nutrition. 58: 1-10

Mora, L. M., A. S. M. T. Moura., C. Scapinello., S. J. Bicudo., I.G. Araujo., F. Curcelli. dan T. F. M. Barros. 2013. Digestible energy of unpeeled cassava root meal and its effect on growth performance and carcass traits in rabbits. World Rabbit Sci. 22: 105-111

Pond, W. G., D. C. Church dan K. R. Pond. 1995. Basic Animal Nutrition and Feeding Fourth Edition. John Willey & Sons, New

Senanayake, S. A., K. K. D. S. Ranaweera, A. Gunaratne dan A. Bamunuarachchi. 2013. Comparative analysis of nutritional quality of five different cultivars of sweet potatoes (*Ipomea batatas, I. Iam*) in Sri Lanka. Food Science & Nutrition. 1(4): 284–291

Siswani, D. M. dan H. Maryanto. 2014. Uji Fisik dan Kimiawi Pakan Ikan yang Menggunakan Bahan Perekat Alami. Prosiding Seminar Hasil Penelitian LPPM UMP. 2014: 25 – 33

Sørensen, M., G. Nguyen, T. Storebakken dan M. Øvreland. 2010. Starch source, screw configuration and injection of steam into the barrel affect the physical quality of extruded fish feed. Aquaculture Research. 41: 419-432

Kaushal, P. V. Kumar. dan H. K. Sharma. 2011. Comparative study of physicochemical, functional, antinutritional and pasting properties of taro (*Colocasia esculenta*), rice (*Oryza sativa*) flour, pigeonpea (Cajanus cajan) flour and their blends. Food Science and Technology. 48: 59-68

Rocha, T. de S., P. de A. C. Ana, dan C. M. L. Franco. 2008. Effect of enzymatic hydrolysis on some physicochemical properties of root and tuber granular starches. Ciênc. Tecnol. Aliment. Campinas. 30(2): 544-551

Sit, N., S. Misra dan S. C. Deka. 2013. Characterization of physicochemical, functional, textural and color properties of starches from two different varieties of taro and their comparison to potato and rice starches. Food Science and Technology Research. 20 (2): 357-365

Thomas, M. dan A. F. B. van der Poel. 1996. Physical quality of animal feed, criteria for pellet quality. In: Physical Quality of Pelleted Feed, a Feed Model Study. M. Thomas (ed). Janny Schokker, Arnhem