Quality and Storability of Pelleted Cassava (*Manihot utilisima*) Leaves var. Bitter

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ABSTRACT: This study was done to determine the effect of pelleting cassava (*Manihot utilisima*) leaves var. bitter on its quality and storability. Based on 2 × 4 factorial experimental design, 2 forms of cassava leaves (powder and pellet) and 4 storage periods (4, 6, 8, and 12 weeks) were applied on the samples. Dried cassava leaves were ground to powder form and then half of it was pelleted using 15% DM cassava starch as binder. Those 2 forms of cassava leaves were stored for 4, 6, 8, or 12 weeks in unvacuumed and vacuumed plastic bags. Evaluation on quality was done in each period; however samples stored in the vacuumed plastic bags only were evaluated in the end of week 12. Pelleted cassava leaves showed lower crude protein (22.04 vs. 24.68%) and lower total carotene (60.72 vs. 84.19 mg/100 g DM) contents ($P<0.01$). After 12 weeks in storage, no effect were showed on crude protein concentration but lower total carotene content was detected ($P<0.01$) on week 12. In addition, storing cassava leaves in vacuumed plastic bags could maintain total carotene content compared to those without vacuumed plastic bags. It can be concluded that pelleting cassava leaves with 15% DM cassava starch decreased crude protein and total carotene content; packing cassava leaves in vacuumed plastic bags could maintain total carotene content up to 12 weeks.

Keywords: Cassava leaves, Manihot utilisima, Pellet, Crude protein, Total carotene.

INTRODUCTION

Cassava (*Manihot esculenta*) or Manihot utilisima was first introduced to the Indonesian archipelago by the Portuguese in the 16th century and was grown commercially in Indonesia since 1810 (Anonymous, ---- cit. Utomo, 2012). Beside of the tuber used as energy source both for food or feed, cassava leaves are also can be used for feed. The content of crude protein (CP) in cassava leaves is relatively high (30.59%) thus it can be used as protein source, especially for ruminants.

One of the problems in using cassava leaves for ruminant feed is the cyanide acid (HCN) content, which is varying among varieties. There are two varieties of cassava: bitter and sweet cassava, which would lead to different levels of HCN contents. Cyanide acid content in bitter cassava is greater than the sweet varieties. The cyanide acid content in bitter cassava varies from 0.02 to 0.25% (Bo Gohl, 1981; Utomo *et al*., 2014), while sweet varieties contain less than 0.01% HCN (Bo Gohl, 1981). In addition, the chemical compositions (% DM) of bitter cassava leaves are: 26.35% dry matter (DM), 24.17% crude fiber (CF), 33.80% non-nitrogen extract (NNE), 4.87% ether extract (EE), and 0.24% cyanide acid (HCN) (Utomo *et al.,* 2014).

In order to conserve its high quality nutrient, cassava leaves can be preserved by various methods. One of preservation methods of cassava leaves that commonly practiced by farmers in Indonesia is by drying them under direct sunlight. Dried cassava leaves not only can be used as energy source for ruminant when fresh forages are abundant, but also may provide protein and minerals (Utomo, 2015). Another preservation method is by pelleting the cassava leaves. Pelleting reduces segregation of the different ingredients within the finished feed ensuring a balanced fraction is consumed; feed in pelleted form reduces natural losses, such as wind loss and spillage loss (Fairfield, 1994).

Nutrient loss may occur in hay during storage due to improper storing method as well as by the length of storage. Packaging or bagging can protect feed materials or final products to be more durable during storage. The increasing durability of packed or bagged feedstuffs during storage is due to that feedstuffs are more protected from environment influences, such as temperature, humidity, and oxygen, as well as insect invasion. This study was done to determine the best preservation methods and duration of storage of dried bitter cassava leaves.

MATERIALS AND METHODS

This research was conducted at the Laboratory of Feed Technology, Department of Nutrition and Feed Science, Faculty of Animal Science, Universitas Gadjah Mada, Yogyakarta. Fresh bitter cassava (Manihot utilisima) leaves were collected from Gunungkidul area, Yogyakarta, dried under direct sunlight, and then ground using hammer mill with 1 mm screen. The cassava leaves powder the divided in two: one part was kept in the powder form, and another part was made into pellet by adding 15% cassava starch (DM) as binder.

Both powder and pellet of bitter cassava leaves were packed using polyethylene bags. All samples were stored in room temperature for 4, 6, 8, and 12 weeks. Especially for 12 weeks storage, sample bags were vacuumed. Each treatment was done in 5 replications. Thus, this research experimental design was based on 2 × 4 factorial experimental design, with 2 forms of cassava leaves (powder and pellet) and 4 storage periods (4, 6, 8, and 12 weeks).

Data collected in this research included CP and total carotene contents of fresh and post-storage bitter cassava, in accordance with a predetermined times. Determination of chemical composition of bitter cassava was done using Weende method (Soejono, 1991; Nahm, 1992), while total carotene content was determined using method described by Harris (1970).

Obtained data were analyzed using the General Linier Model Multivariate procedure of SPSS ver. 22 (IBM, USA). Comparisons of means for feed forms and storage periods were done by contrast test with Duncan's new multiple range test (Gomez and Gomez, 1984) when the effects of feed forms and storage periods ($P \leq 0.05$) were detected.

RESULTS AND DISCUSSION

Chemical composition

The Wendee analysis of fresh bitter cassava leaves showed that bitter cassava leaves contained 44.28% dry matter (DM), 93.46% organic matter (OM), 26.14% crude protein (CP), 8.67% ether extract (EE), 13.14% crude fiber (CF), 45.51% non-nitrogenous extract (NNE), and 108.27 mg/100 g total carotene contents. With its high CP and low CF contents (>20 and <18%, respectively), bitter cassava can be classified as protein source feedstuffs (Utomo, 2012). However, its N as a crude protein constituent is also present in the cell wall. Thus, bitter cassava leaves is classified as protein source roughages in respect to its high CP and low CF contents.

After dried under direct sunlight, bitter cassava leaves showed a decrease in their CP and total carotene contents. Dried bitter cassava leaves contained 97.58% DM, 23.76% CP, and 97.05 mg/100 g total carotene contents, which showed a decline in CP and total carotene contents (9.10 and 10.36%, respectively) compared with the fresh one. The decrease in CP and total carotene contents is due to the direct heating under the sun.

Post-storage crude protein content

Data in Table 1 showed that although pelleting process lowered CP content ($P<0.01$), CP content of bitter cassava leaves in both forms were above 20% (24.68 and 22.04%, respectively), which indicated that the pellet is still can be classified as high protein feed. The decreasing in CP content of pelleted bitter cassava leaves was related to the 15% cassava starch addition during pelleting process. Since starch is low in CP content, thus by adding it in bitter cassava leaves

diluted the CP content of pellets bitter cassava leaves. The high temperature of steam applied during pelleting process also affected CP content. This low CP content of pelleted bitter cassava leaves is related to the denaturation of protein due to its high temperature during the steaming process.

Table 1. Crude protein content (%DM) of powder and pelleted bitter cassava leaves after being stored for 4, 6, 8, and 12 weeks

Storage period (weeks)	Storage form		Mean
	Powder	Pellet	
4	24.99 ± 0.60	22.00 ± 0.48	23.50 ± 1.66
6	24.37 ± 0.21	21.56 ± 0.31	22.97 ± 1.50
8	25.50 ± 0.74	21.52 ± 0.91	23.51 ± 2.24
12	25.11 ± 0.41	21.72 ± 0.41	23.41 ± 1.83
12 (vacuumed)	23.42 ± 0.82	23.42± 0.82	23.42 ± 0.78
Mean	24.68 ± 0.90[a]	22.04 ± 0.89[b]	

[a,b] Means in the same row with different superscripts differ at P<0.01

Crude protein content of bitter cassava leaves was not affected by the length of storage period, which was above 20% (Table 1). This means that dried bitter cassava leaves stored for 12 weeks in both powder or pellet form can still be used as protein source forage. Likewise, storing bitter cassava leaves in vacuumed plastic bags did not show any differences compared to those stored in unvacuumed plastic bags.

Post-storage total carotene

The results showed that the pelleting cassava leaves reduced total carotene content (P<0.01; Table 2). Similar to the reduction of CP content, this decreasing total carotene content was caused by the cassava starch addition as much as 15% during the pelleting process. Cassava starch contains very low total carotene content, thus adding cassava starch resulted in lower total carotene content of bitter cassava leaves pellet. The decrease of total carotene content in pellet also might be due heat created from steaming step during pelleting process. Heat might partially destruct carotene contained in bitter cassava leaves when steaming were performed during pelleting process. Steaming is needed in pelleting process since heat converts starch into glue shaft that serves as an adhesive (bounding) for pellet.

Table 2. Total carotene content (mg/100 g DM) of powder and pelleted bitter cassava leaves after being stored for 4, 6, 8, and 12 weeks

Storage period (weeks)	Storage form		Mean
	Powder	Pellet	
4	84.03 ± 2.38	66.26 ± 1.44	75.15 x ± 9.55
6	83.07 ± 3.13	66.23 ± 3.35	74.65 x ± 9.39
8	86.57 ± 2.23	61.07 ± 2.87	73.82 x ± 13.66
12	82.62 ± 4.67	52.28 ± 8.89	67.45 y ± 17.34
12 (vacuumed)	84.65 ± 2.20	57.74 ± 4.30	71.19 x ± 14.55
Mean	84.19 a ± 3.37	60.72 b ± 7.02	

[a,b] Means in the same row with different superscripts differ at P<0.01
[x,y] Means in the same column with different superscripts differ at P<0.01

A noticeable decrease ($P<0.01$) of total carotene of bitter cassava leaves occurred when they were stored for 12 weeks. However, total carotene of bitter cassava leaves that stored in vacuumed plastic bags did not change. Storing bitter cassava leaves in vacuumed container might maintain total carotene content due to less oxygen in the container and denser feed materials in the pack, thus the oxidation process of feed materials is reduced.

CONCLUSIONS

Several conclusions can be drawn from this research:
1. Bitter cassava leaves contains 26.14% CP and 108.27 mg/100 g total carotene.
2. Direct drying under sun light decrease CP and total carotene contents by 9.10 and 10.36%, respectively.
3. Pelleting process decreased CP and total carotene contents.
4. Storing up to 12 weeks either in vacuumed or did not affect CP content, but only bitter cassava leaves stored in vacuumed packages could maintain total carotene content up to 12 weeks of storage.

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