Effect of using different levels of cassava meal in a concentrate cassava peel diet on chemical composition, in vitro gas production, and rumen fermentation

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Abstract. This study was designed to evaluate effects of using different levels of cassava meal in a concentrate cassava peel diet on chemical composition, in vitro gas production (IVGP) and rumen fermentation. The treatments applied were: A=cassava peel (20%)+ cassava meal (70%)+cassava leaves (5%)+moringa leaves (5%); B=cassava peel (20%)+ cassava meal (60%)+cassava leaves (10%)+moringa leaves (10%); C=cassava peel (20%)+ cassava meal (50%)+cassava leaves (15%)+moringa leaves (15%) cassava meal; D=cassava peel (20%)+ cassava meal (40%)+cassava leaves (20%)+moringa leaves (20%); E=cassava peel (20%)+ cassava meal (30%)+cassava leaves (25%)+moringa leaves (25%) with 3 replications arranged in a Randomized Block Design (RBD). The result showed that the increasing levels of cassava meal in the ration significantly increased organic matter (OM) and nitrogen-free extract (NFE) content (P<0.05), but reduced crude protein (CP), ether extract (EE), crude fiber (CF), neutral detergent fiber (NDF), and acid detergent fiber (ADF) contents. Similarly, a significant increased (P<0.01) were found in values of cumulative in vitro gas production, dry matter and organic matter digestibility, but decreased NH3 concentration (P<0.05) due to the increased of cassava meal. It is concluded that increasing levels of cassava meal in concentrate has led to higher OM content of the ration and being available for rumen fermentation.

1. Introduction
Cassava (Manihot utilissima Cranz) is one of potential feeds for ruminants in some tropical regions and parts of the cassava plants that have been commonly used for feed are leaves, peels, tubers and cassava meal. Previous studies reported that DM, CP, CF and OM contents of cassava leaves were 27.2%; 31.4%; 12.8%; and 94.6% respectively [1]. Cassava peels contained CP (7.1% DM), EE (2% DM), CF (14% DM), and NFE (66.4% DM) [2]. Meanwhile, cassava meal contained DM (87.3%), OM (7.9% DM), CP (2.1% DM), CF (3.2% DM), ME (3.2 Mcal/kg DM), and starch 73.8% [3].

Cassava leaves has been reported to have high potential as protein supplement on fibrous basal diet and a higher daily gain of growing sheep (112 g/d) was recorded compared to *gliricidia* leaves supplementation (97.1 g/d) [4]. The use of cassava peels as an energy source to supplement maize stover basal diet had the highest OM digestibility and daily weight gain of crossbred Limousine (81.6% and 1.35 kg/d respectively) at 30% [3]. Similar results were obtained when cassava meal was used to supplement maize stover [5]. The present study aimed to evaluate effects of using different levels of cassava meal in a concentrate cassava peel diet on chemical composition, *in vitro* Gas Production, and Rumen Fermentation.
2. Materials and method

2.1. Location and time
This study was conducted in the Nutrition and Animal Feed Laboratory Faculty of Animal Science Brawijaya University and abattoir in Malang from September to November 2020.

2.2. Materials
Materials used were feedstuffs consisted of cassava peels, cassava meal, cassava leaves, and *Moringa oleifera* leaves.

2.3. Methods
This study used an in vitro gas production technique arranged in a Randomized Block Design (RBD) with the following treatments: A= cassava peel (20%)+cassava meal (70%)+cassava leaves (5%)+moringa leaves (5%); B= cassava peel (20%)+cassava meal (60%)+cassava leaves (10%)+moringa leaves (10%); C= cassava peel (20%)+cassava meal (50%)+cassava leaves (15%)+moringa leaves (15%) cassava meal; D= cassava peel (20%)+cassava meal (40%)+cassava leaves (20%)+moringa leaves (20%); E= cassava peel (20%)+cassava meal (30%)+cassava leaves (25%)+moringa leaves (25%) with 3 replications. Rumen fluids used were collected from crossbred Limousine cattle slaughtered in abattoir in Malang. Variables measured were chemical composition, in vitro gas production and DM and OM digestibility. Table 1 presented the chemical composition and formulation of the treatments.

| Feedstuffs        | Chemical Composition (%) | Formulation (%) |
|-------------------|--------------------------|-----------------|
|                   | DM | Ash | CP | EE | CF | NFE | NDF | ADF | A  | B  | C  | D  | E  |
| Cassava peel      | 24.32 | 7.51 | 9.18 | 1.72 | 9.88 | 71.72 | 28.36 | 9.36 | 20  | 20  | 20  | 20  | 20  |
| Cassava meal      | 84.41 | 2.63 | 2.86 | 0.84 | 2.90 | 90.77 | 8.96 | 2.18 | 70  | 60  | 50  | 40  | 30  |
| Cassava leaves    | 25.73 | 9.87 | 25.48 | 9.72 | 18.46 | 36.47 | 46.50 | 47.15 | 5   | 10  | 15  | 20  | 25  |
| Moringa leaves    | 24.23 | 12.97 | 27.38 | 6.78 | 10.35 | 43.51 | 17.15 | 13.39 | 5   | 10  | 15  | 20  | 25  |

* Percentage based on dry matter.
* Based on 100% of DM.

2.4. Chemical analysis
Proximate analysis was carried out according to the procedure of AOAC [6] to determine DM, OM, CP, EE, and CF. Determination of fiber fractions (ADF and NDF) was carried out according to the procedure of [7]. In vitro gas production measurement, DMD and OMD values were done following the method of [8 and 9].

2.5. Statistical analysis
Data obtained were analyzed by analysis of variance (ANOVA) and followed by Duncan’s Multiple Range Test if the treatments gave significant effect on the variables measured.

3. Results and discussion

3.1. Chemical composition of different levels cassava meal in ration
Table 2. presented the chemical composition of treatments. The OM content of the ration ranging from 92.13% (treatment E) – 95.74% (A), CP ranging from 9.10% (A) – 19.28% (E), EE from 1.22% (A) – 4.65% (E), CF from 4.76% (A) – 8.57% (E), ADF from 7.34% (A) – 13.09% (E), NDF from 16.03% (A) – 33.14% (E) and NFE ranging from 50.51% (E) – 71.28% (A). The values reported here are still in the range of values reported earlier by [3] and [8].
Table 2. Chemical composition of treatments.

| Treatments | Chemical Composition (%) |
|------------|--------------------------|
|            | DM | OM* | CP* | EE* | CF* | ADF* | NDF* | NFE* |
| A          | 90.62 | 95.74 | 9.10 | 1.22 | 4.76 | 7.34 | 16.03 | 71.28 |
| B          | 91.47 | 94.97 | 11.50 | 1.69 | 5.66 | 8.50 | 17.50 | 67.59 |
| C          | 91.87 | 94.02 | 12.56 | 2.35 | 6.82 | 10.19 | 19.03 | 64.16 |
| D          | 92.29 | 93.06 | 14.46 | 3.16 | 7.56 | 11.68 | 22.57 | 60.17 |
| E          | 90.88 | 92.13 | 19.28 | 4.65 | 8.57 | 13.09 | 33.14 | 50.51 |

*) Based on 100% of DM.

Table 2 showed that the higher cassava meal in ration resulted in higher OM and NFE values, but CP, EE, CF, NDF, and ADF contents were lower due to the increased in cassava meal. The highest CP content was found in treatment E (19.28% DM), it seems to be related to the lowest proportion of cassava meal (30% of ration) and higher proportion of cassava (25%) and Moringa leaves (25%) in the diet. As reported that CP content in Cassava leaves is 21% [11] and Moringa leaves 33.9%[12]. The contents of CF, ADF, and NDF were much influenced by the presence of cassava meal, where the higher proportion of cassava meal, the lower fiber content in all treatments.

3.2. IVGP, digestibility, and NH3
The in vitro gas production (IVGP), dry matter digestibility (DMD), and organic matter digestibility (OMD) of the ration were presented in Table 3. Statistical analysis showed that treatments significantly affected values of IVGP, DMD and OMD at P<0.01, and NH3 concentration at P<0.05. The highest IVGP values were recorded in treatment A (164.76 ml/500 mg DM) followed by treatments B, C, D, and E. Similar trends were also observed in DMD, and OMD values, in which those values were reduced by the increased proportion of cassava meal. Meanwhile, the NH3 concentration in the rumen decreased with the higher addition of cassava meal. The presence of cassava and moringa leaves as protein sources must have been the reason contributing to the difference in NH3 values. Ammonia concentration of all treatments were adequate to support rumen microbial activity, especially for degrading nutrients. This was indicated by higher values of both DMD and OMD as the proportion of cassava leaves and moringa leaves increased.

Table 3. IVGP, DMD, and OMD of treatments.

| Parameters | A | B | C | D | E | SEM |
|------------|---|---|---|---|---|-----|
| IVGP* (ml/500mg DM) | 164.77<sup>a</sup> | 157.76<sup>d</sup> | 148.86<sup>c</sup> | 142.07<sup>b</sup> | 128.71<sup>a</sup> | 3.723 |
| NH3* (mg/l) | 78.77<sup>a</sup> | 90.67<sup>a</sup> | 92.37<sup>a</sup> | 93.50<sup>a</sup> | 112.77<sup>b</sup> | 5.182 |
| DMD* (%) | 80.74<sup>b</sup> | 80.95<sup>b</sup> | 75.83<sup>b</sup> | 72.73<sup>b</sup> | 65.85<sup>a</sup> | 1.893 |
| OMD* (%) | 84.11<sup>d</sup> | 83.32<sup>cd</sup> | 78.96<sup>bc</sup> | 76.17<sup>b</sup> | 71.32<sup>a</sup> | 1.499 |

Different superscript in the same row showed the significant effect at P<0.05 (*) and P<0.01 (**)

4. Conclusions
In conclusion, increased levels of cassava meal in the ration increased its OM content and rumen fermentation indicated by increasing values of IVGP, DMD, and OMD but, rumen NH3 concentration has appeared in an opposite direction.

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