Nutrition quality test of fermented waste vegetables by bioactivator local microorganisms (MOL) and effective microorganism (EM4)

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Abstract. Livestock feed mostly used waste which has low nutrition content and one way to improve feed content by fermentation. The objective of this study was to evaluate the effect of bioactivator types on fermented vegetables waste for animal feed. The research was conducted in Nutrition and Animal Feed Laboratory, Universitas Sumatera Utara from May until July 2016. The research was factorial completely randomized design of 3 x 3 with 3 replications. Factor I were bioactivator types which were control, local bioactivator and EM4 (Effective Microorganisms 4). Factor II were time of incubation 3, 5 and 7 days. Parameters were moisture content, ash, Nitrogen Free Extract (NFE) and Total Digestible Nutrient (TDN). The results showed that bioactivator types either local activator or EM4 has highly significantly different effect (P<0.01) on water content, NFE and TDN on vegetables waste while there was no different between local bioactivator with EM4 on all parameters. Time of incubation 7 days has highly significantly different effect (P<0.01) on NFE, TDN and significant different (P<0.05) on water content and ash. In conclusion local bioactivators could improve animal feed by fermenting vegetables waste and it is more available for livestockers.

1. Introduction

One of the biggest contributors in the environment is waste from traditional markets. Traditional market waste has slightly different characteristics than housing waste. The composition of market waste is more dominant organic waste rather than inorganic waste. Organic market waste consists of vegetable waste and fruit waste. As in Indonesia mostly waste is dumped into landfill which cause environmental problem, Ginting [1] suggested for any organic waste to be used which then will give enormous benefits.

Vegetable waste has potential as animal feed ingredients. This waste can be directly used as animal feed. But low levels of crude protein and high coarse fiber are usually the limiting factor in their use as feed. These wastes are also susceptible to decay and damage, so treatment is needed to prolong the shelf life and suppress the anti-nutritional effects generally in the form of alkaloids.

According to Susangka et al. [2] vegetable waste has a crude fiber of 5-38%. The coarse fiber is very high and can be derived by fermentation with local microorganisms (MOL) and Effective Microorganism 4 (EM4). According to Soccol et.al [3] fermentation was a very old way/thousand years ago which supported higher final concentration of products with environmental advantages.
Local microorganisms (MOL) contain microorganisms that have the potential to break down organic matter. EM4 is one of the microbes that can degrade crude fiber content because it has the ability to produce enzymes laccases and peroxidases that can break down and dissolve the lignin contained in feed ingredients that serve as a source of energy for livestock Mangisah et al. [4].

2. Materials and Methods

This research has been conducted in Nutrition and Feed Science Laboratory of Animal Husbandry Program of Faculty of Agriculture, University of Sumatera Utara from May 2016 to June 2016.

The materials for making MOL were 1 kg rotten papaya, bananas, pineapple, ½ kg rotten water spinach, spinach and long bean, 1 kg sugar, 60 g yeast tape, yeast tempe and yoghurt. Araujo [5] found lactic acid bacteria (BAL) in yoghurt. Other source of microorganism was EM4. Fermented vegetables waste were consisted of mustard, cabbage and corn chobot.

The research method used in this study was experimentally using a complete randomized design (RAL) with 3 x 3 and 3 replication factorial patterns. So that yielded 9 combination of treatment. The first factor is the type of bioactivator with 3 treatments, namely:

R0: No Fermentation (control)
R1: Local Microorganism (MOL)
R2: EM4 (Effective Microorganism 4)

The second factor is the duration of fermentation with 3 treatments, namely:

S1: 3 days
S2: 5 days
S3: 7 days

Parameters of research were water content, dry matter, ash content, TDN, BETN, crude fiber, crude fat, rough protein while there were 4 parameters already submit into local journals however it was not yet published (dry matter, rough protein, crude fiber, crude lipid).

3. Result and Discussion

Table 1. Recapitulation of research results

| Treatment | Water content (%) | Dry material (%) | Rough fat (%) | Crude protein (%) | Rough fiber (%) | Ash content (%) | BETN (%) | TDN (%) |
|-----------|-------------------|-----------------|---------------|------------------|----------------|----------------|----------|---------|
| R0        | 4.37             | 95.62           | 1.73          | 4.30             | 15.53          | 21.76          | 56.65    | 60.77   |
| R1        | 8.41             | 91.58           | 1.23          | 6.74             | 11.41          | 21.73          | 58.86    | 64.58   |
| R2        | 8.38             | 91.61           | 1.36          | 6.90             | 11.50          | 21.79          | 58.43    | 64.22   |
| S1        | 7.16             | 92.83           | 1.48          | 5.04             | 13.30          | 21.73          | 58.43    | 62.88   |
| S2        | 7.73             | 92.26           | 1.44          | 5.67             | 12.93          | 21.80          | 58.14    | 63.10   |
| S3        | 6.27             | 93.72           | 1.40          | 7.23             | 12.22          | 21.76          | 57.36    | 63.59   |
| R0S1      | 4.49             | 95.50           | 1.73          | 4.30             | 15.64          | 21.80          | 56.51    | 60.65   |
| R0S2      | 4.46             | 95.53           | 1.72          | 4.29             | 15.67          | 21.77          | 56.54    | 60.69   |
| R0S3      | 4.17             | 95.82           | 1.75          | 4.33             | 15.28          | 21.73          | 56.89    | 60.97   |
| R1S1      | 8.58             | 91.43           | 1.28          | 5.33             | 12.22          | 21.65          | 59.51    | 64.09   |
| R1S2      | 9.30             | 90.69           | 1.25          | 6.26             | 11.34          | 21.81          | 59.32    | 64.58   |
| R1S3      | 7.36             | 92.64           | 1.15          | 8.65             | 10.68          | 21.75          | 57.75    | 65.08   |
| R2S1      | 8.42             | 91.58           | 1.42          | 5.50             | 12.06          | 21.73          | 59.27    | 63.91   |
| R2S2      | 9.45             | 90.55           | 1.36          | 6.47             | 11.76          | 21.82          | 58.57    | 64.02   |
| R2S3      | 7.29             | 92.70           | 1.31          | 8.73             | 10.68          | 21.82          | 57.44    | 64.74   |

Description: A. B. C. D. E : Very significant effect (P<0.01)
ab : Have real effect (P<0.01)
tn : Not real
The result of bioactivator type research gave no significant different effect (P>0.05) to water content, dry matter, crude fat, crude protein, BETN and TDN of vegetable waste. The duration of fermentation had significantly different effect (P <0.01) on crude protein, crude fiber, BETN, TDN and significantly different (P <0.05) to water content, dry matter, ash content. The interaction of type of bioactivator and fermentation duration gave a significantly different effect(P<0.05).

3.1. Effect of Treatment on Water Content of Fermented Vegetables Wastes
The highest average moisture content was 9.45% in the R2S2 treatment (vegetable waste fermented with EM4 bioaktivator and fermentation time of 5 days) and the lowest was 4.17% in the non-fermentation treatment. The results showed that fermentation water content was higher than vegetable waste water content without fermentation. This indicates that the fermentation was already going well because the microbes on EM4 and MOL have started to grow and use water to ferment Buckle [6]. Vegetable waste water content was also a by-product of the fermentation process.

The result of variance analysis showed that bioactivator type treatment gave a very real effect (P <0.05) to fermented vegetable waste water content. The long treatment of fermentation also had significant effect (P <0.05) on the fermented vegetable water content. The interaction of type bioactivator treatment and fermentation time had no significant effect (P > 0.05) to water content. This means that the two treatment factors did not interact to increase the water content of Fermented vegetable wastewater.

The result of variance analysis showed that the influence of interaction factor between bioactivator type and fermentation time had no significant effect (P> 0.05) on fermented vegetable water content. so no further test was done.

3.2. Effect of Treatment on Dry Material Content of Fermented Vegetables
The highest dry matter content was 95.82% in the non-fermentation treatment and the lowest drying material was 90.55% in the R2S2 treatment ((fermented vegetable waste with EM4 bioactivator and 5 day fermentation time) . The fermentation dry material was lower than the dry matter of waste vegetables without fermentation. Low dry matter due to microbes using carbohydrates. minerals and other substances for microbial growth Kamara et al. [7].

The result of variance analysis showed that bioactivator type treatment had very real effect (P <0.01) on dry matter of vegetable waste. The long treatment of fermentation also had a significant effect (P <0.05) on dry matter of vegetable waste. The interaction of bioactivator type treatment and fermentation time had no significant effect (P > 0.05) to the content of dry matter of vegetable waste. This means that the two treatment factors do not interact to reduce the dry matter content of fermented vegetable waste.

Compared to other treatments, possibly due to existing organic materials. such as carbohydrates. fats. and unused proteins as a source of nutrients for microbes. since no addition of EM4 was possible. Unlike the case in the addition of EM4 treatment. food substances. such as carbohydrates. fats and proteins used the source of nutrients for microbes contained therein.

The result of variance analysis showed that the influence of interaction factor between bioactivator type and fermentation time had no significant effect (P> 0.05) on dry matter of fermented vegetable waste. so no further test was done. The unreal effect is caused by the dry matter treatment is converted into energy (heat) which causes the decrease of dry matter substrates.

3.3. The Effect of Treatment on Crude Fat Content of Fermented Vegetable Waste.
The highest rate of 1.73% was found in the treatment without fermentation and the lowest average was found at 1.15% in the R1S3 treatment ((vegetable waste fermented with MOL biocativator and 7 day fermentation time). From result of analysis of bioactivator type treatments have very real effect (P <0.01) to crude fat of vegetable waste. However. the long treatment of fermentation has no significant effect (P> 0.05) on the crude fat of vegetable waste. The result of variance analysis showed that there was no interaction between bioactivator type treatment and fermentation length on crude fat of fermented vegetable waste. This means that the two factors do not interact with each other to lower the
raw fat of vegetable waste.

The result of variance analysis showed that the fermentation treatment had no significant effect (P > 0.05) to the crude fat of vegetable waste. It can be seen that the crude fat content decreases with increasing length of fermentation. This happens because the process of fermentation transforms complex compounds into simple compounds so that microbes can be utilized. This is in accordance with the statement of Mucra [8] which states that the fermentation aims to break down complex compounds to be simpler so that can be utilized by microbes for its growth as an energy source in the form of VFA (Volatile Fatty Acid) in addition to energy from carbohydrates easily digested. Length of fermentation up to 7 days was not significantly different for the crude fat content in vegetable waste. This was because EM4 and MOL both contain the enzyme cellulase so there is not much of a rough fat change. This was consistent with the results of the Selviana [9] which states that each fermentor has the same enzyme ability to change the crude fat content. The absence of significant differences in crude fat content in each treatment was suspected because the content of fermentor was less dominant population of bacteria producing lipase enzymes that digest fat function but more dominant enzyme cellulase enzyme.

3.4. Effect of Treatment on Rough Protein Content of Fermented Vegetable Waste

The highest mean rough protein was 8.73% in the R2S3 treatment ((vegetable waste fermented with EM4 bioactivator and fermentation time of 7 days) and the lowest was 4.29% in the fermented treatment. The fermented crude protein was higher than the crude protein of vegetable waste Without fermentation.

The result of variance analysis showed that bioactivator type treatment had highly significant effect (P < 0.01) on crude protein of vegetable waste. Likewise in the long treatment of fermentation has a very significant effect (P < 0.01) on crude protein of vegetable waste. The result of variance analysis showed that the interaction between bioactivator type and fermentation treatment had significant effect (P < 0.01) on crude protein of vegetable waste. This means that the two treatment factors interact to raise the crude protein of vegetable waste.

This is consistent with the statement of Fajaruddin et al.. [10] which states that major microorganisms in EM4 solution consist of photosynthetic bacteria (bacteria fototropik), lactic acid bacteria, yeast, Actinomycetes and fermented mushrooms.

The addition of EM4 to the fermentation process serves to increase the growth of microorganisms found in the solid so that it can work optimally in breaking the unbroken cells and increasing the crude protein content due to the activity of microorganisms in the dry solids of organic sludge in bio gas units.

The result of variance analysis showed that the influence of interaction factor between bioactivator type and fermentation time had significant effect (P < 0.05) to crude protein of fermented vegetable waste. so that further test was done. The influence of this type of biokativator increases the crude protein by increasing the length of fermentation resulting in interaction. This occurs because at the time of fermentation an increase in the number of microbial cell mass. This is consistent with the statement of Chandra et al.. [11] which states that the rice husk fermented with EM4 has a significantly higher effect than the unfermented ones, because at the time of fermentation there is an increase in the mass of microbial cell. The increase occurs because in the process of microbial fermentation produces microbial cells in the form of single cell proteins, microbial enzymes and microbial metabolism results are amino acids, nucleotides, and proteins.

3.5. Effect of Treatment on Rough Fiber Fertilizer Fermentation Wastes

The highest rate of crude fiber was 15.67% in the non-fermented treatment and the lowest was 10.68% in the R2S3 treatment ((vegetable waste fermented with EM4 bioactivator and fermentation time of 7 days). The coarse fermented fiber was lower than the crude fiber of the vegetable waste Without fermentation. This shows that the crude fiber of fermented vegetable waste is decreasing.
The result of variance analysis showed that bioactivator type treatment had highly significant effect (P < 0.01) on crude fiber of vegetable waste. The long treatment of fermentation was very significant (P < 0.01) to the crude fiber of fermented vegetable waste. The interaction between bioactivator type treatment and fermentation length did not give significant effect (P > 0.05) to crude fiber of vegetable waste. This means that the two treatment factors do not interact to reduce the crude fiber of vegetable waste.

The result of variance analysis showed that the influence of interaction factor between bioactivator type and fermentation time had no significant effect (P > 0.05) to crude fiber of fermented vegetable waste. So no further test was done. The effect is not significant is due to coarse fiber treatment decreases with the length of fermentation so that no interaction occurs.

3.6. Effect of Treatment on Ash Content of Fermented Vegetables

The highest rate of ash content was 21.82% in the R2S3 treatment (vegetable waste fermented with EM4 bioactivator and fermentation time of 7 days) and the lowest was 21.65% in the R1S1 treatment (vegetable waste fermented with MOL bioactivator and 3 day fermentation time).

The result of variance analysis showed that bioactivator type treatment had no significant effect (P > 0.05) to ash content of fermented vegetable waste. The fermentation treatments had significant effect (P < 0.05). The interaction between bioactivator type and fermentation time gave a significant effect (P < 0.05) to ash content of vegetable waste. This means that the two treatment factors interact to reduce the ash content of vegetable waste.

3.7. Effect of Treatment on BETN Levels of Fermented Vegetable Waste

The highest rate of BETN was 59.51% in the R1S1 treatment (vegetable waste fermented with MOL bioactivator and 3 day fermentation time) and the lowest 56.51% in the non-fermented treatment.

The result of variance analysis showed that bioactivator type treatment had a very significant effect (P < 0.01). The fermentation treatments had a very significant effect (P < 0.01) on BETN of fermented vegetable waste. Interaction Treatment of bioactivator type and fermentation time had a significant effect on BETN content of fermented vegetable waste. This means that the two treatment factors interact with each other to lower vegetable waste BETN.

The result of variance analysis showed that the influence of interaction factor between bioactivator type and fermentation length significantly (P < 0.05) to BETN of fermented vegetable waste. So that further test was done. BETN levels have increased indicating that many components of organic material in the digestible vegetable waste so that more energy will be generated.

3.8. Effect of Treatment on TDN Level of Fermented Vegetable Waste

The highest rate of TDN was 65.08% in the R1S3 treatment (vegetable waste fermented with MOL bioactivator with 7 day fermentation time) and the lowest 60.97% in the fermented treatment.

The result of variance analysis showed that the bioactivator type and fermentation treatment had a very significant effect (P < 0.01) on TDN of vegetable waste. The interaction of bioactivator type treatment with fermentation time was not significantly different. This means that the two treatment factors are not mutually interacting to decrease TDN of vegetable waste.

The result of variance analysis showed that the influence of interaction factor between bioactivator type and fermentation time had no significant effect (P > 0.05) to TDN of fermented vegetable waste. So no further test was done. The unreal effect is due to TDN of fermented vegetable waste is the total of feed substance needed by the livestock which will increase with decreasing the raw fiber content of feed.

3.9. Description between MOL and EM4 on Price and Availability

A description has been done to compare MOL and EM4 in terms of price and availability. MOL actually was already socialized by Agricultural Department of Indonesia by extention program Agricultural Department [12] to local farmer thus many local farmers could done MOL. As MOL use
rotten materials. Any production cost was on tape yeast, sugar and youghurt. Meanwhile local farmers have to bought EM4 whenever they want to use EM4 as bioactivator. Local farmers anywhere even to a very remote area could have MOL while EM4 only could find in at least a regency or subregency. In conclusion, MOL was more feasible to be used as bioactivators.

| Table 2. Description between MOL and EM4 on Price and Availability |
|---------------------------------------------------------------|
| Price/Liter Availabilty                                      |
| MOL 5,000          Available everywhere                      |
| EM4 22,000         Available only in regency and sub regency |

4. Conclusions

Either MOL or EM4 as bioactivator has an effect to increase water content, crude protein, BETN. TDN of vegetable waste and lowering dry material, coarse fat, crude fiber. The duration of fermentation / 7 days has an effect on increasing dry matter, crude protein, ash content. TDN of vegetable waste and lower water content, crude fiber and vegetable waste BETN. The interaction of bioactivator type and fermentation time have an effect on increasing crude protein of vegetable waste. In conclusion both MOL and EM4 was good as bioactivator on fermenting vegetable waste. However, MOL was better as its price was cheaper than EM4 and it was also more available for farmers.

References

[1] Ginting N 2017 Benefits of using biogas technology in rural area: Karo District on supporting local action plan for greenhouse gas emission reduction of North Sumatera province 2010-2020 International Conference on Biomass: Technology Application and Sustainable Development IOP Publishing IOP Conf. Series: Earth and Environmental Science 65 (2017) 012007 doi: 10.1088/1755-1315/65/1/012007.

[2] Susangka I, Haetami K dan Andriani Y 2006 Evaluasi Nilai Gizi Limbah Sayuran Produk Cara Pengolahan Berbeda dan Pengaruhnya Terhadap Pertumbuhan Ikan Nila (Evaluation Value of Waste Product Vegetables the Different Technique and the Influence of Parrotfish Growth) UNPAD Bandung

[3] Soccol, Ricardo C, Ferreira da Costa E S, Letti L A J, Karp S G, Wociejchowski A L and Porto de Souza Vandenberge L 2017 Recent developments and innovations in solid state fermentation. http://www.journals.elsevier.com/biotechnology-research-and-innovation/

[4] Mangisah I N, Suthama dan Wahyuni H I 2009 Pengaruh Penambahan Starbio dalam Ransum Berserat Kasar Tinggi terhadap Performa Itik (the Influences of adding Starbio in high Crude Fiber Rations of duck Performance) Universitas Diponegoro Semarang

[5] Araújo, Diego D, Alessandro B, Amorim, Mayra A D, Saleh, Curcelli F, Pedro L, Perdigon, Silvio J, Bicudo, Dirlei A and Berto 201 J of Animal Nutrition 2 (2016) 149-153

[6] Buckle K A, Edwards R A, Fleet G H and Wooton M 1985 Ilmu Pangan (Food Science) Terjemahan: Purnomo H dan Adiono UI Press Jakarta

[7] Kamara D S, Rahman S D and Gaffar S 2008 Enzymatic degradation of cellulose from banana stalks for glucose production using cellulolytic activity of Tricoderma viride In: Proceeding of the International Seminar on Chemistry p 692-696

[8] Mucra D A 2007 Pengaruh Fermentasi Serat Buah Kelapa Savit terhadap Komposisi Kimia dan Kecernaan Nutrien secara In Vitro (Fermentation Influences of Palm Oil Fiber of Chemical Composition and Nutrient Digestibility by In Vitro Tesis Pascasarjana Peternakan. Universitas Gadjah Mada Yogyakarta

[9] Selviana E 2000 Pengaruh Fermentasi Starbio Terhadap Kandungan Protein Kasar, Lemak Kasar dan Serat Kasar Kulit Buah Nanas (Starbio Fermentation Influences by
Containing Crude protein. Crude Fat and Crude Fiber from Pineapple Rind) Skripsi Fakultas Peternakan Universitas Mataram Mataram

[10] Fajaruddin, Junus M dan Setyowati E 2013 Pengaruh lama fermentasi EM4 terhadap kandungan protein kasar padatan kering lumpur organik unit gas bio (the influences of length fermentation EM4 by containing crude dry solid protein of organic mud of gass bio) Jurnal Ilmu-Ilmu Peternakan 23(2) 14-18

[11] Andra, Kereh V G, Untu I M dan Rembet B W 2013 Pengayaan nilai nutritif sekam padi berbasis bioteknologi “effective microorganism 4” (EM4) sebagai bahan pakan organik (value nutritif enrichment of rich husk based in biotechnology “effective microorganism 4” (EM4) as organic material food) Universitas Sam Ratulangi Manado

[12] Indonesia Agricultural Department Annual Report 2011