INTRODUCTION

The Special Region of Yogyakarta has a relatively high potential for vegetable waste due to the presence of many traditional markets as places for high-intensity vegetable transactions. Vegetables and fruit waste in traditional markets reaches 84% of total market waste (Cahyari and Sahroni, 2015). This waste was not optimally utilized and had an impact on environmental pollution. Processing vegetables and fruits waste into alternative feed can increase livestock productivity with low costs. Besides, it can reduce the pile of vegetable waste that pollutes the environment. The problem with vegetable waste as ruminant feed is the high heavy metal content. Heavy metals consumed by ruminants decrease rumen fermentation performance and feed digestibility. Heavy metals become enzyme inhibitors in the gastrointestinal tract cause feed degradation was not optimal. Inhibited nutrient utilization causes a decrease in livestock productivity (Yue et al., 2007; Mudhoo and Kumar, 2013; Marounek and Joch, 2014). Heavy metals such as Pb, Cu, and Cr in vegetables exceed the maximum limit (Zhou et al., 2016; Latif et al., 2018). Based on this description, this study aims to determine the potential and heavy metal contamination of traditional market vegetable waste in the Special Region of Yogyakarta.
MATERIALS AND METHODS

SAMPLES COLLECTION
Vegetable waste samples were collected from 11 traditional markets in the Special Region of Yogyakarta. Three traditional markets in Sleman District include Demangan, Condong Catur, and Gamping, three traditional markets in Bantul District covering Piyungan, Barongan, and Bantul. Meanwhile, five traditional markets in Jogja City include Kranggan, Beringharjo, Kotagede, Prawirotaman, and Giwangan. From each traditional market, a total of 12 kg of vegetable waste was collected at three different points as replications, with 4 kg of the sample at each replication. Vegetable waste samples were stored in plastic bags for laboratory analysis.

IDENTIFY THE TYPE OF VEGETABLE WASTE
A total of 1-2 kg of collected vegetable waste was used for identification. Vegetable waste was separated based on the variety and weighed to get the percentage of each vegetable waste.

VEGETABLE WASTE DRYING
The unsorted vegetable waste sample (1 kg), divided into three parts and wrapped in a weighed paper bag. The wrapped samples were heated in a 55°C oven for 3-5 days to obtain air-dried samples. The dry waste samples were ground into powder using a Wiley 2 mm grinding machine. Vegetable waste samples were analyzed proximate (crude protein, crude fat, crude fiber, dry matter, and organic matter) using the AOAC (2005) and heavy metals (Pb, Cu, and Hg) through the atomic absorption spectroscopy (AAS) method (Hina et al., 2011).

DATA ANALYSIS
Data were analyzed by one-way analysis of variance (ANOVA) with a completely randomized design, followed by Duncan's Multiple Range Test (DMRT) to determine the difference between mean values (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

The potential of traditional market vegetable waste in the Special Region of Yogyakarta is presented in Table 1. The results showed that each traditional market in Sleman District, Bantul District, and Jogja City had high potential based on the vegetable variety. Each traditional market has an average of 12 types of vegetable waste and was dominating by vegetables such as cabbage, spinach, water spinach, mustard greens, Chinese cabbage, green beans, chayote, cucumber, carrots, tomatoes, long beans, and jackfruit peels. A variety of waste will have various types of nutrients and potential as ruminant feed. According to some researchers, vegetable waste such as carrots, cabbage, spinach, cauliflower, tomatoes, banana leaves, corn husks, onion peels, cassava leaves, taro, jackfruit, cucumbers, potatoes, pumpkins, leek, celery, lettuce, broccoli, bananas, oranges, grapes, melons, pears, and plums have the potential as feed for ruminants (Ezeldin et al., 2016; Wadhwa and Bakshi, 2013; Bakshi et al., 2016; Mahgoub et al., 2020).

There are many traditional markets in the Special Region of Yogyakarta. According to Statistics Indonesia (2019), the Special Region of Yogyakarta has 357 traditional markets. The number of traditional markets is due to the high people’s preference for purchases in traditional markets. People choose vegetables at an affordable price. Vegetables were mostly produced in rural areas in the Special Region of Yogyakarta, which affected the variety of vegetables in traditional markets. Furthermore, the supply of vegetables also comes from other producer areas, such as Magelang and Boyolali, which have vegetable production centers.

The chemical composition analysis of traditional market vegetable waste in the Special Region of Yogyakarta is shown in Table 2. The chemical composition of traditional market vegetable waste in Sleman District, Bantul District, and Jogja City were no different (P>0.05). It was due to the high percentage of vegetable variety in each district almost same.

The chemical composition analysis showed that vegetable waste protein content reached 19%, and fiber lower than 30% would support livestock growth. The protein and the fiber content of vegetable waste are almost equivalent to elephant grass (Pennisetum purpureum S.) at 13.47-19.43% and 29.60-35.50% (Haryani et al., 2018), and Setaria grass (Setaria sp. Setacelea) about 20.31-23.44% and 24.02-30.41% (Fitriana et al., 2017). According to Bakshi et al. (2016), vegetable waste is a good source of crude fiber and energy, especially for ruminants. Sheep requires about 9.8-16.7% protein (National Research Council, 1985), vegetable waste as an alternative feed can increase productivity at an economical cost. According to research by Retnami et al. (2014), the utilization of 100% vegetable waste as wafers feed-in sheep has the highest body weight gain and a final weight of 25.6% higher than conventional feed.

The result of the analysis of heavy metal content in vegetable waste is presented in Table 3. The results showed that the contamination of heavy metals Pb, Cu, and Hg in Sleman District, Bantul District, and Jogja City did not show a significant difference (P>0.05). Pb contamination in all traditional markets is below 0.01 mg/kg. The maximum level of Pb contamination in forage for feed is 10-50 mg/kg (Reis et al., 2010; Adamse et al., 2017). Pb contamination in vegetable waste was still lower than the maximum level of Pb feed contamination. The maximum Hg
Table 1: The potential of traditional market vegetable waste in the Sleman District, Special Region of Yogyakarta

| No. | Market Name  | Vegetable Type | Botanical Name         | Total (g) | Percentage (%) |
|-----|--------------|----------------|------------------------|-----------|----------------|
| 1.  | Demangan     | Basil leaves   | Ocimum basilicum       | 1033      | 18.384%        |
|     |              | Jackfruit peels| Artocarpus heterophyllus| 534       | 9.503%         |
|     |              | Grated coconut | Cocos nucifera         | 453       | 8.062%         |
|     |              | Papaya         | Carica papaya          | 444       | 7.902%         |
|     |              | Cucumber       | Cucumis sativus        | 393       | 6.994%         |
|     |              | Banana leaves  | Musa paradisiaca       | 373       | 6.638%         |
|     |              | Water spinach  | Ipomoea aquatica      | 345       | 6.140%         |
|     |              | Others         |                        | 330       | 5.873%         |
|     |              | Spinach        | Amaranthus spp.        | 279       | 4.965%         |
|     |              | Eggplant       | Solanum melongena      | 263       | 4.681%         |
|     |              | Bamboo shoots  | Dendrocalamus asper    | 235       | 4.182%         |
|     |              | Young jackfruit| Artocarpus heterophyllus| 206    | 3.666%         |
|     |              | Mustard greens | paracrinensis          | 170       | 3.025%         |
|     |              | Chinese cabbage| Brassica rapa subsp. pekinensis| 144 | 2.563%         |
|     |              | Cabbage        | Brassica oleracea      | 140       | 2.492%         |
|     |              | Ridge gourd    | Luffa acutangula       | 107       | 1.904%         |
|     |              | Scallion       | Allium fistulosum      | 42        | 0.747%         |
|     |              | Chayote        | Sechium edule          | 34        | 0.605%         |
|     |              | Green beans    | Phaseolus vulgaris     | 22        | 0.392%         |
|     |              | Celery         | Apium graveolens       | 21        | 0.374%         |
|     |              | Long beans     | Vigna cylindrica (L.)  | 18        | 0.320%         |
|     |              | Carrot         | Daucus carota          | 12        | 0.214%         |
|     |              | Corn husk      | Zea mays               | 8         | 0.142%         |
|     |              | Grape          | Vitis vinifera         | 7         | 0.125%         |
|     |              | Cassava leaves | Manihot utilissima     | 6         | 0.107%         |
| 2.  | Condong Catur| Chinese cabbage| Brassica rapa subsp. pekinensis| 1755 | 34.574%        |
|     |              | Chayote        | Sechium edule          | 1142      | 22.498%        |
|     |              | Cabbage        | Brassica oleracea      | 670       | 13.199%        |
|     |              | Water spinach  | Ipomoea aquatica      | 606       | 11.939%        |
|     |              | Cassava leaves | Manihot utilissima     | 244       | 4.807%         |
|     |              | Mustard greens | paracrinensis          | 242       | 4.768%         |
|     |              | Tomato         | Solanum lycopersicum  | 157       | 3.093%         |
|     |              | Eggplant       | Solanum melongena      | 135       | 2.660%         |
|     |              | Green beans    | Phaseolus vulgaris     | 51        | 1.005%         |
|     |              | Spinach        | Amaranthus spp.        | 35        | 0.690%         |
|     |              | Long beans     | Vigna cylindrica (L.)  | 15        | 0.296%         |
|     |              | Scallion       | Allium fistulosum      | 11        | 0.217%         |
|     |              | Onion peels    | Allium cepa            | 9         | 0.177%         |
|     |              | Chili          | Capsicum annuum        | 4         | 0.079%         |
| 3.  | Gamping      | Water spinach  | Ipomoea aquatica      | 1448      | 32.701%        |
|     |              | Spinach        | Amaranthus spp.        | 627       | 14.160%        |
|     |              | Kenikir leaves | Cosmos caudatus        | 527       | 11.902%        |
|     |              | Cabbage        | Brassica oleracea      | 384       | 8.672%         |
| Market Name | Vegetables Type | Botanical Name | Total (g) | Percentage (%) |
|-------------|----------------|----------------|-----------|----------------|
| Piyungan    | Cabbage        | Brassica oleracea | 2338     | 58.877%        |
|             | Spinach        | Amananthus spp.   | 587      | 14.782%        |
|             | Mustard greens | Brassica rapa subsp. parachinensis | 505 | 12.717%        |
|             | Bay leaves     | Syzygium polyanthum | 312 | 7.857%        |
|             | Bamboo shoots  | Dendrocalamus asper | 131 | 3.299%        |
| Barongan    | Bitter melon   | Momordica charantia | 98  | 2.468%        |
|             | Cucumber       | Cucumis sativus   | 958      | 19.740%        |
|             | Bitter melon   | Momordica charantia | 753 | 15.516%        |
|             | Cabbage        | Brassica oleracea | 689      | 14.197%        |
|             | Tomato         | Solanum lycopersicum | 560 | 11.539%        |
|             | Eggplant       | Solanum melongena | 261 | 5.378%        |
|             | Water spinach  | Ipomea aquatica   | 257      | 5.296%        |
|             | Klutuk banana leaves | Musa balbisiana | 235 | 4.842%        |
|             | Carrot         | Daucus carota     | 180      | 3.709%        |
|             | Long beans     | Vigna cylindrica (L.) | 175 | 3.606%        |
|             | Scallion       | Allium fistulosum | 161      | 3.318%        |
|             | Cassava leaves | Manihot utilissima | 143 | 2.947%        |
|             | Banana         | Musa paradisiaca  | 138      | 2.844%        |
|             | Taro           | Colocasia esculenta | 112 | 2.308%        |
|             | Others         |                 | 83       | 1.710%        |
|             | Celery         | Apium graveolens  | 55       | 1.133%        |
|             | Cauliflower    | Brassica oleracea var. Botrytis | 44 | 0.907%        |
|             | Mustard greens | Brassica rapa subsp. parachinensis | 44 | 0.907%        |
### Table 3: The potential of traditional market vegetable waste in the Jogja City, Special Region of Yogyakarta

| No. | Market Name   | Vegetable Type | Botanical Name                   | Total (g) | Percentage (%) |
|-----|---------------|----------------|----------------------------------|-----------|----------------|
| 1.  | Kranggan       | Green beans    | Phaseolus vulgaris               | 1178      | 27.796%        |
|     |               | Red apple      | Malus domestica                  | 424       | 10.005%        |
|     |               | Long beans     | Vigna cylindrica (L.)            | 348       | 8.211%         |
|     |               | Spinach        | Amaranthus spp.                  | 324       | 7.645%         |
|     |               | Chinese cabbage| Brassica rapa subsp. Pekinensis  | 287       | 6.772%         |
|     |               | Mustard greens | parachinensis                    | 272       | 6.418%         |
|     |               | Cabbage        | Brassica oleracea                | 269       | 6.347%         |
|     |               | Bamboo shoots  | Dendrocalamus asper              | 219       | 5.168%         |
|     |               | Star fruit     | Averrhoa carambola               | 179       | 4.224%         |
|     |               | Corn husk      | Zea mays                         | 162       | 3.823%         |
|     |               | Celery         | Apium graveolens                 | 144       | 3.398%         |
|     |               | Orange         | Citrus reticulata                | 115       | 2.714%         |
|     |               | Carrot         | Daucus carota                    | 91        | 2.147%         |
|     |               | Scallion       | Allium fistulosum                | 89        | 2.100%         |
|     |               | Banana         | Musa paradisiaca                | 49        | 1.156%         |
|     |               | Eggplant       | Solanum melongena               | 31        | 0.731%         |
|     |               | Tomato         | Solanum lycopersicum            | 30        | 0.708%         |
|     |               | Chili          | Capsicum annuum                  | 12        | 0.283%         |
|     |               | Mangosteen peels| Garcinia mangostana             | 9         | 0.212%         |
|     |               | Rambutan peels | Nephelium lappaceum             | 6         | 0.142%         |
| 2.  | Beringharjo    | Mustard greens | Brassica rapa subsp. parachinensis | 924     | 28.839%        |
|     |               | Cabbage        | Brassica oleracea                | 907       | 28.308%        |
|     |               | Eggplant       | Solanum melongena               | 322       | 10.50%         |
|     |               | Madeira vine   | Anredera cordifolia              | 300       | 9.363%         |
|     |               | Scallion       | Allium fistulosum                | 259       | 8.084%         |
|     |               | Celery         | Apium graveolens                 | 243       | 7.584%         |
|     |               | Carrot         | Daucus carota                    | 221       | 6.898%         |
|     |               | Parsley        | Petroselinum crispum             | 28        | 0.874%         |
| 3.  | Kotagede       | Cabbage        | Brassica oleracea                | 3222      | 74.774%        |
| Vegetable                | Species                          | Weight (g) | Percentage |
|-------------------------|----------------------------------|------------|------------|
| Potato                  | *Solanum tuberosum*             | 339        | 7.867%     |
| Scallion                | *Allium fistulosum*             | 308        | 7.148%     |
| Mustard greens          | *Brassica rapa subsp. parachinensis* | 148        | 3.435%     |
| Long beans              | *Vigna cylindrica* (L.)          | 130        | 3.017%     |
| Bay leaves              | *Syzygium polyanthum*           | 66         | 1.532%     |
| Celery                  | *Aptium graveolens*             | 54         | 1.253%     |
| Others                  |                                  | 32         | 0.993%     |
| Chili                   | *Capsicum annuum*               | 4          | 0.093%     |
| Klutuk banana leaves    | *Musa balbisiana*               | 4          | 0.093%     |
| Carrot peels            | *Daucus carota*                 | 2          | 0.046%     |
| 4. Prawirotaman          | Sweet leaves *Sauropus androgynus* | 1619       | 37.827%    |
| Jackfruit peels         | *Artocarpus heterophyllus*      | 783        | 18.294%    |
| Water spinach           | *Ipomea aquatica*               | 530        | 12.383%    |
| Spinach                 | *Amaranthus* spp.               | 475        | 11.098%    |
| Cabbage                 | *Brassica oleracea*             | 435        | 10.164%    |
| Chayote                 | *Sechium edule*                 | 136        | 3.178%     |
| Carrot                  | *Daucus carota*                 | 102        | 2.383%     |
| Orange                  | *Citrus reticulata*             | 71         | 1.659%     |
| Banana peels            | *Musa paradisiaca*              | 33         | 0.771%     |
| Kenikir leaves          | *Cosmos caudatus*               | 26         | 0.607%     |
| Scallion                | *Allium fistulosum*             | 24         | 0.561%     |
| Tomato                  | *Solanum lycopersicum*          | 19         | 0.444%     |
| Cassava leaves          | *Manihot utilissima*            | 18         | 0.421%     |
| Bay leaves              | *Syzygium polyanthum*           | 7          | 0.164%     |
| Green beans             | *Phaseolus vulgaris*            | 2          | 0.047%     |
| 5. Giwangan             | Mustard greens *Brassica rapa subsp. parachinensis* | 3268       | 85.438%    |
| Tomato                  | *Solanum lycopersicum*          | 378        | 9.882%     |
| Eggplant                | *Solanum melongena*             | 105        | 2.745%     |
| Corn husk               | *Zea mays*                      | 74         | 1.935%     |

| **Table 4:** Chemical composition of traditional market vegetable waste in the Special Region of Yogyakarta (%) |
|---------------------------------------------------------------|
| **District** | **Dry Matter** | **Organic Matter** | **Crude Protein** | **Crude Fiber** | **Ether Extract** | **Total Digestible Nutrient** |
|-------------|----------------|-------------------|-------------------|-----------------|------------------|-------------------------------|
| Sleman      | 93.19          | 19.43             | 19.03             | 20.66           | 2.13             | 63.00                         |
| Bantul      | 89.79          | 22.96             | 18.90             | 23.42           | 1.69             | 68.80                         |
| Jogja City  | 91.04          | 22.30             | 22.73             | 20.11           | 1.47             | 68.33                         |
| Average     | 91.06          | 21.81             | 19.98             | 21.76           | 1.75             | 67.09                         |
| SE          | 1.913          | 1.189             | 0.966             | 1.110           | 0.191            | 1.713                         |
| P-value     | 0.802          | 0.507             | 0.235             | 0.434           | 0.478            | 0.230                         |

*dry weight

| **Table 5:** The heavy metal content of traditional market vegetable waste in the Special Region of Yogyakarta (dry matter sample) |
|--------------------------------------------------------------------------------------------------------------------------|
| **District** | **Lead (Pb, mg/kg)** | **Copper (Cu, mg/kg)** | **Mercury (Hg; µg/kg)** |
|--------------|---------------------|-----------------------|-------------------------|
| Bantul       | <0.01               | 18.39                 | 23.46                   |
| Sleman       | <0.01               | 18.50                 | 33.12                   |
| Jogja City   | <0.01               | 12.54                 | 14.52                   |
contamination in the feed is 0.1 mg/kg. The Hg content in vegetable waste is still lower than the contamination limit based on Adamse et al. (2017). The standard of Hg content in ruminant feed is 0.1 mg/kg. Hg contamination in vegetable waste is below the maximum contamination limit.

The heavy metals content in vegetables was affected by several factors, such as pesticides and herbicides application, fertilizers, air pollution, soil and irrigation water contaminated with waste, and poor handling during the distribution process (Onakpa et al., 2018; Ruzaidy and Amid, 2020). The problem of utilizing vegetable waste as feed is high heavy metals contamination causes risks to livestock. Heavy metals such as Pb, Cu, and Cr, contained in vegetables, exceed normal permissible limits. Heavy metals consumed by ruminants will reduce rumen fermentation performance and decrease feed digestibility. Heavy metals become enzyme inhibitors in the digestive tract caused less feed degradation. Low nutrient utilization decreased livestock productivity (Yue et al., 2007; Marounek and Joch, 2014).

The consumption of heavy metals through the feed can become a residue in meat and is dangerous if consumed by humans. Research by Sudiyono (2011) shows that cattle that consume heavy metals lead heavy metal contamination of meat to exceed the maximum limit, causing human health problems. Sheep that grazing in landfill area contains heavy metals on lamb meat over the permissible limit (Rahayu et al., 2016). Consuming heavy metals causes damage to the brain, lungs, kidneys and liver function, blood composition, and other essential organs. Long-term exposure can lead to physical, muscular, and neurological degenerative processes that imitate diseases such as multiple sclerosis, Parkinson’s disease, Alzheimer’s disease, muscular dystrophy, hypertension, cancer, and may even cause death (Mudgal et al., 2010; Jaishankar et al., 2014) (Table 4 and 5).

CONCLUSION

Traditional market vegetable waste in the Special Region of Yogyakarta is potentially utilized as a ruminant feed based on the variety and chemical composition. Heavy metal contamination of Pb, Cu, and Hg in vegetable waste was still below the permissible limit for ruminant feed.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHORS CONTRIBUTION

Muhsin Al Anas designed, performed the experiment and wrote the manuscript. Himmatul Hasanah collected the samples and analyzed the data. Ali Agus supervised all the study and revised the manuscript. All authors read and approved the final manuscript for publication.

REFERENCES

- Adamse P, van der Feels-Klerx HJ, de Jong J (2017). Arsenic, lead, cadmium and mercury in animal feed and feed materials; Trend analysis of monitoring results collected in the Netherlands.Wageningen. https://doi.org/10.18174/416680
- AOAC (2005). Official Methods of Analysis. 20th ed. Association of Official Analytical Chemists, Washington DC, USA.
- Bakshi MPS, Wadhwa M, Makkar HPS (2016). Waste to worth: Vegetable wastes as animal feed. CAB Rev. Perspect. Agric. Vet. Sci. Nutr. Nat. Resour. 11: 1 – 26. https://doi.org/10.1079/PAVSNRR201611012
- Cahyari K, Sahroni A (2015). Effect concentration of Chili pepper (Capsicum annum L.) and Tabasco pepper (Capsicum frutescens L.) on biogas production from organic waste. J. Bahan Alam Terbarukan 4: 8 – 15.
- Ezeldin I, Massaad O, Omer SA (2016). Evaluation of some vegetable wastes as feedstuff for ruminants. Int. J. Sci. Res. 5: 628 – 631. https://doi.org/10.21275/v5i3.NOVI161789
- Fitriana PR, Akbarillah HT, Supratman JWR, Limun K, Fax BT (2017). Quality of the nutrition of Sctaria spacclella grass harvested based on cutting intervals. J. Sain Peternak. Indonesia. 12: 444 – 453. https://doi.org/10.31186/jspi. id.12.4.444-453
- Gomez KA, Gomez AA (1984). Statistical Procedure for Agricultural Research. John Wiley and Sons, USA.
- Haryani H, Norlindawati AP, Norfadzrin F, Azman A (2018). Yield and nutritive values of six Napier (Pennisetum purpureum) cultivars at different cutting age. Malaysian J. Vet. Res. 9: 6 – 12.
- Hina B, Rizwani GH, Naseem S (2011). Determination of toxic metals in some herbal drugs through atomic absorption spectroscopy. Pak. J. Pharm. Sci. 24: 353 – 358.
- Jaishankar M, Tseten T, Anbalagan N, Mathew BB, Beeregowda KN (2014). Toxicity, mechanism and health effects of some heavy metals. Interdiscip. Toxicol. 7: 60 – 72. https://doi.org/10.2478/intox-2014-0009
- Latif A, Bilal M, Asghar M, Azeem M, Ahmad MI, Abbas A, Ahmad MZ, Shahzad T (2018). Heavy metal accumulation...
in vegetables and assessment of their potential health risk. J. Environ. Anal. Chem. 5: 1000234. https://doi.org/10.4172/2380-2391.1000234

• Mahgoub O, Kadim IT, Eltahrir Y, Al-Lawatia S, Al-Ismail AM (2020). Nutritional value of vegetable wastes as livestock feed. Sultan Qaboos Univ. J. Sci. [SQUJS] 23: 78 – 84. https://doi.org/10.24200/sqjjs.vol23iss2pp78-84

• Maronnek M, Joch M (2014). Effects of heavy metals and arsenate on the Ovine rumen fermentation in vitro. Agric. Trop. Subtrop. 47: 106 – 108. https://doi.org/10.2478/ats-2014-0014

• Mudgal V, Madaan N, Mudgal A, Singh RB, Mishra S (2010). Effect of toxic metals on human health. Open Nutraceuticals J. 3: 94– 99. https://doi.org/10.2174/18763960010030100094

• National Research Council (1985). Nutrient Requirements of Sheep. National Academy Press, Washington DC.

• Onakpa MM, Njan AA, Kalu OC (2018). A review of heavy metal contamination of food crops in Nigeria. Ann. Glob. Heal. 84: 488 – 494. https://doi.org/10.29024/aogb.2314

• Rahayu P, Munawaroh IS, Elok K (2016). Comparison of heavy metal residues on sheep that grazing in landfill area before and after elimination process. Pages 319–326 in Proceedings of International Seminar on Livestock Production and Veterinary Technology 2016. https://doi.org/10.14334/Proc.Intsem.LPVT-2016-p.319-326

• Reis LSLS, Pardo PE, Camargos AS, Oba E (2010). Mineral element and heavy metal poisoning in animals. J. Med. Med. Sci. 1: 560 – 579.

• Retnani Y, Saenah A, Taryati (2014). Vegetable waste as wafer feed for increasing productivity of sheep. Asian J. Anim. Sci. 8: 24 – 28. https://doi.org/10.3923/ajas.2014.24.28

• Ruzaidy NIM, Amid A (2020). Heavy metal contamination in vegetables and its detection: A review. Sci. Herit. J. 4: 01 – 05. https://doi.org/10.26480/gws.01.2020.01.05

• Statistics Indonesia (2019). Market and Trade Center Distribution By Classifications 2019. Available at https://www.bps.go.id/indicator/173/1875/1/sebaran-pasar-dan-pusat-perdagangan-menurut-klasifikasi.html (verified 2 February 2021).

• Sudiyono S (2011). Efforts of elimination of residual heavy metals in beef cattle from the waste disposal site locations with conventional maintenance. Sains Peternakan. 9(1): 1 – 7.

• Wadhwa, M., and S. P. M. Bakshi. 2013. Utilization of fruit and vegetable wastes as livestock feed and as substrates for generation of other value-added products (HPS Makkar, Ed.). FAO, Bangkok.

• Yue ZB, Yu HQ, Wang ZL (2007). Anaerobic digestion of cattail with rumen culture in the presence of heavy metals. Bioresour. Technol. 98: 781 – 786. https://doi.org/10.1016/j.biortech.2006.03.017

• Zhou H, Yang WT, Zhou X, Liu L, Gu JF, Wang WL, Zou JL, Tian T, Peng PQ, Liao BH (2016). Accumulation of heavy metals in vegetable species planted in contaminated soils and the health risk assessment. Int. J. Environ. Res. Public Health. 13: 289 – 300. https://doi.org/10.3390/ijerph13030289