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# A Prototype of chopping machines as an organic waste processor

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## ABSTRACT

Waste utilization is used in various sectors such as industry, Food, Manufacturing, etc. Food or vegetable waste is one type of organic waste. Organic waste can be used as organic fertilizer and animal feed. This study aims to make a prototype of an organic waste-chopping machine. Furthermore, the chopped results can be used as raw material for compost or animal feed. The main driving components in the prototype organic waste chopper are electric motors with a power of 1/2 HP and 2880 rpm, reducers with a rotation ratio of 1/20, a pulley ratio of 3/4, and a belt type A-66. Analysis of the prototype design of the organic waste chopper machine, namely the calculation of the planning of the v-belt, pulley, and the calculation of the rate and torque on the blade shaft. The capacity of the chopping results is distinguished based on 2 types of tests: testing using a reducer and not a reducer. The types of chopped waste were vegetable waste, organic skin waste, and cassava. Testing with a reducer produces shredded waste with a 16.5 kg/hour capacity. Also, 8.7 kg/hour is used for organic skin waste, and 26.13 kg/hour is used for cassava. Meanwhile, the test results without using a reducer resulted in chopped vegetable waste as much as 111.84 kg/hour and 93.72 kg/hour for organic skin waste.

**Keywords**: Organic waste, prototype of shredding machine, design and construction, shredding capacity

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## INTRODUCTION

In the 4.0 era, technological developments, especially manufacturing technology, developed very quickly. This can be felt with the increasing number of technologies that can improve the society prosperity. One of them is a technology that can be used to process waste into more useful products. Inorganic or organic waste can be utilized into more useful products, such as being the raw material for fertilizers and/or one of animal feed ingredients. Waste utilization is done to improve the quality of a product [1, 2]. There are two types of waste, namely organic waste, and inorganic waste.

Organic waste is waste or food waste, rotten vegetables, or leftover material from plant processing, which can be used as compost and a mixture of animal feed. [3, 4]. Meanwhile, inorganic waste is waste that comes from non-renewable natural resources, such as plastic, glass, damaged cars. Inorganic waste can be recycled into various types of crafts, plastic waste can be used as building material (concrete) [2, 3, 5, 6].

Organic fertilizers come from natural materials such as plant and animal residues. Organic fertilizers contain several advantages, such as high nutrient levels and the ability to absorb and release and dissolve in water so that they are easily absorbed by plants [7]. Organic fertilizers are produced by doing the composting process [8, 9]. Quality compost is compost that has completely decomposed and does not cause adverse effects on plant growth [10, 11]. The characteristics of good compost are dark brown compost, insoluble in water, the value of the carbon to nitrogen ratio between 10-20 from the raw material, gives a good effect when applied to the soil, and has almost the same temperature as the environment, and does not smell [11].

Animal feed is one of the factors that can increase livestock productivity. Utilization of organic waste has not been used optimally. Organic waste can be used as fuel, organic fertilizer, and industrial raw materials [12, 13]. In addition, some agricultural products are widely used as a source of energy and protein for animal feed because of their low price [14].

Based on this background, to facilitate the processing of organic waste into compost and animal feed, organic waste must be chopped first. It aims to accelerate the decomposition process

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and facilitate the mixing of raw materials in the processing of animal feed. This study aims to make a prototype of an organic waste chopping machine that can be used by fertilizer or animal feed producers, so that the production process is easier and improved. Also, in this study we want to know the significance difference between chopping machines with reducer and without reducer.

## METHOD

*Working Principle of Chopping Machine*

An electric motor is used as the main driving force in this organic waste shredder. Furthermore, the electric motor will rotate the pulley which is connected to the electric motor shaft. The rotation of the electric motor pulley will rotate the pulley 1 on the reducer shaft in a ratio of 1:20 which then the 2nd shaft of the reducer will rotate followed by the pulley attached to the reducer shaft 2. The pulley connected to the 2nd shaft of the reducer will rotate the pulley attached to the reducer shaft. blade shaft. The principal scheme of the organic waste shredder can be seen in Figure 1.

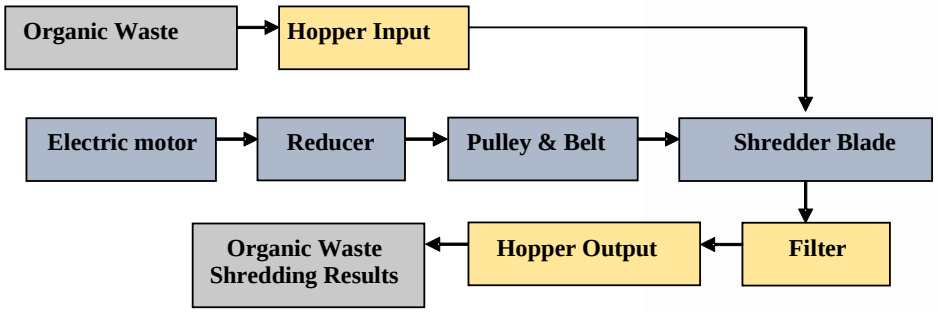


Figure 1. Working principle of organic waste shredder

*Design of chopping machine*

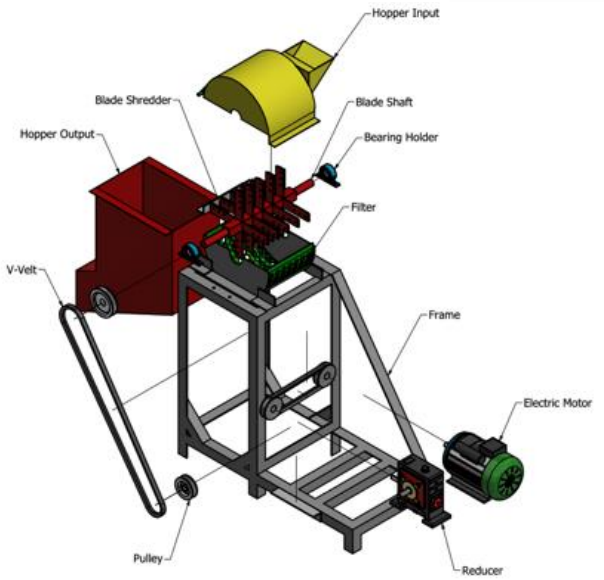


Figure 2. The Prototype design

Based on Figure 3, it can be seen the parts of the organic waste chopper machine design. The organic waste shredder consists of input hopper, rotary knife shaft, bearing holder, strainer, pulley, v-belt, frame, output hopper, reducer, and electric motor. The size of the pulley used in making the prototype of this chopping machine is 3 inches for the input pulley, and 4 inches for the output pulley, while the v-belt used is A-66. The rotation rate produced by an electric motor with HP power is 2880 rpm, and the damper ratio used is 1:20.

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## RESULT AND DISCUSSION

Based on the calculation, the results of pulley and belt specification are shown in Table 1.

In this study, the types of waste that will be enumerated are vegetable waste, organic peels waste .

Table 1 Pulley and Belt Specification

| No | Pulley and Belt | Result |
|---|---|---|
| 1 | Pulley circular speed | Reducer = 0.57 m/s<br>Without reducer = 8.6 m/s |
| 2 | Pulley roving force | Reducer = 66.56 kgf<br>Without reducer = 4.41 kg/f |
| 3 | Belt tension | Reducer = 21.6 kgf/cm$^2$ |
| 4 | Belt maximum tension | Reducer = 137.7 kgf/cm$^2$<br>Without reducer = 98.747 kgf/cm$^2$ |
| 5 | Number of belts | 1.28 (min. 1 piece) |
| 6 | Number of belts turns | Reducer = 0.33 rad/s<br>Without reducer = 5.11 rad/s |
| 7 | Belt life | Reducer = 138.88 hour<br>Without reducer = 129.375 hour |

Table 2. Prototype with Reducer

| With *reducer* | Vegetable | Peels | Tubers |
|---|---|---|---|
| RPM | 108 | 108 | 108 |
| Input | 1,000 gr | 1,000 gr | 1,000 gr |
| Output | 825 gr | 874 gr | 871 gr |
| Time | 3 minutes | 6 minutes | 2 minutes |
| % Results | 82.5% | 87.4% | 87.1% |
| Capacity | 16.5 kg/hour | 8.7 kg/hour | 26.13 kg/hour |

Table 3. Prototype without Reducer

| Without *Reducer* | Vegetable | Peels | Tubers |
|---|---|---|---|
| RPM | 2.160 | 2.160 | 2.16 |
| Input | 1,000 gr | 1,000 gr | 1,000 gr |
| Output | 932 gr | 781 gr | - |
| Time | 30 second | 30 second | - |
| % Result | 93.2% | 78.1% | - |
| Capacity | 111.84 kg/hour | 93.72 kg/hour | - |

and cassava waste. As for the test results of the prototype with reducer can be seen in table 2 and without reducer are shown in Table 3.


Figure 3. Prototype Output with Reducer

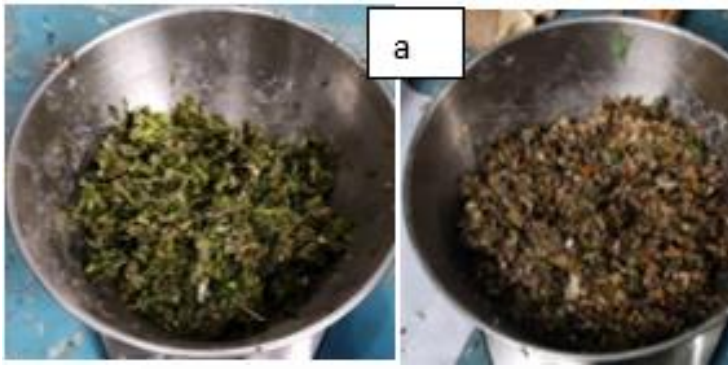


Figure 4. Prototype Output without Reducer

Based on Figure 3 and 4, it is known that the smooth chopping results obtained from the prototype without reducer. The optimal waste result from enumeration for prototype without reducer is vegetable waste. For waste type of tubers cannot be chopped because it is thrown out when trying to put it into the input hopper.

### *Discussion*

The prototype with reducers, it can chop organic waste, but the chopping results for vegetable waste and organic peels are not too smooth. The capacity obtained for the prototype with a reducer for vegetable waste is 16.5 kg/hour, for organic peels waste as much as 8.7 kg/hour, and for tuber waste as much as 26.7 kg/hour. For prototypes without reducers, they can chop organic waste with fine chopping results, but prototypes without reducers cannot count tubers waste because when the waste is put in, it is thrown back out. The capacity obtained for vegetable waste is 111.84 kg/hour and for organic peels waste the capacity is 93.72 kg/hour.

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## CONCLUSION

In this study, the highest chopping capacity was found in the prototype of a waste chopping machine without a reducer with a capacity of 111.84 kg/hour for chopping vegetable waste. Meanwhile, the highest chopping results were obtained by the prototype of the organic waste chopping machine in the process of chopping tubers with a capacity of 26.13 kg/hour. The prototype of the organic waste chopping machine with reducer can optimally chop sweet potatoes waste with a fine chop of 26.13 kg/hour, while for chopping vegetable waste and organic peels waste the chopper machine has problems with twisted stalks and the chopping results are stuck in between swivel blade. The prototype without a reducer can optimally chop vegetable waste and organic peels with fine chopping results and each capacity obtained is 111.84 kg/hour for vegetable waste, and 93.72 kg/hour for organic leather waste. The prototype without reducer cannot chop the sweet potatoes waste, when the waste material is inserted, the sweet potatoes is thrown back out, this happens because the input hopper does not have a cover.

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## REFERENCES

[1] W. R. Kanusa and H. Iyabu, "Pemberdayaan Masyarakat Desa Pangi Dalam Pengolahan Limbah Organik dan Anorganik," *Jurnal ABDIMAS UMTAS*, pp. 329-341, 2020.

[2] E. Bachtiar, M. A. Muzakkir, Takwin, S. Gusty and N. K. Nur, "Kuat Tekan dan Tarik Belah Pada Beton yang Menggunakan Agregat Kasar Limbah Plastik," *Rekayasa Sipil*, pp. 22-28, 2021.

[3] W. Satriawi, E. W. Tini and A. Iqbal, "Pengaruh Pemberian Pupuk Limbah Organik Terhadap Pertumbuhan dan Hasil Tanaman Mentimun (Cucumis sativus L.)," *Jurnal Penelitian Pertanian Terapan* , pp. 115-120, 2019.

[4] Ashlihah, M. M. Saputri and A. Fauzan, "Pelatihan Pemanfaatan Limbah Rumah Tangga Organik menjadi Pupuk Kompos," *Jurnal Pengabdian Masyarakat Bidang Pertanian*, vol. I, no. 1, pp. 30-33, 2020.

[5] S. Hamdiani, N. Ismillayli, S. R. Kamali, S. Hadi and s. h. pranoto, "Pengolahan Mandiri Limbah Organik Rumah Tangga Untuk Mendukung Pertanian Organik Lahan Sempit," *Jurnal. Pijar MIPA*, pp. 151-154, 2018.

[6] S. H. Pranoto, S. Yatnikasari, M. N. Asnan and R. I. Yaqin, "Desain dan Analisis Mata Pisau Pencacah Untuk Pengolahan Sampah Plastik Menggunakan Finite Element Analysis," *Jurnal Infotekmesin*, pp. 147-152, 2020.

[7] R. Harahap, Gusmeizal and E. Pane, "Efektifitas Kombinasi Pupuk Kompos Kubis-Kubisan (Brassicaceae) dan Pupuk Organik Cair Bonggol Pisang terhadap Produksi Kacang Panjang (Vigna Sinensis L.)," *Jurnal Ilmiah Pertanian (JIPERTA)*, pp. 135-143, 2020.

[8] T. Nur, A. R. Noor and M. Elma, "Pembuatan Pupuk Organik Cair Dari Sampah Organik Rumah Tangga Dengan Bioaktivator EM4 (Effective Microorganisme)," *Konversi*, pp. 44-51, 2016.

[9] D. A. Mayasari, M. D. Kurniatie and Amalia, "Atasi Limbah Organik Melalui Pelatihan Pembuatan Pupuk Kompos Metode Keranjang Takakura Kepada Kelompok Dawis Cempaka Semarang," *Abdimasku*, vol. IV, no. 1, pp. 49-54, 2021.

[10] N. Fuadi, "Optimalisasi Pengolahan Limbah Organik Pasar Tradisional dengan Pemanfaatan Efective Microorganisme (EM4)," *Jurnal Teknosains*, pp. 73-79, 2020.

[11] E. S. Antu and Y. Djamalu, "Desain Mesin Pencacah Sampah Organik Rumah Tangga Untuk Pembuatan Pupuk Kompos," *Jurnal Teknologi Pertanian Gorontalo*, pp. 57-65, 2018.

[12] R. A. A. Gunadi, Misriandi, Farihen, N. Yusuf, A. Sumardi and H.

e-ISSN 2623-0313
p-ISSN 3032-1972

Murdiratno, "Sociopreneurship Pengolahan Sampah Organik Menjadi Pakan Ikan dan Pakan Ternak," *ABDI DOSEN (Jurnal Pengabdian Pada Masyarakat)*, pp. 373-385, 2021.

[13] Hermanto and Fitriani, "Pemanfaatan Kulit dan Daun Singkong Sebagai Campuran Bahan Pakan Ternak Unggas," *Jurnal Riset Teknologi Industri*, pp. 284-295, 2019.

[14] N. L. G. Budiari and I. N. Suyasa, "Optimalisasi Pemanfaatan Hijauan Pakan Ternak (HPT) Lokal Mendukung Pengembangan Usaha Ternak Sapi," *PASTURA*, pp. 118-122, 2019.

[15] A. S. Nurrohkayati, N. A. Bahry and M. Khairul, "Desain Mesin Perajang Singkong Menggunakan Cakram 4 Mata Pisau dengan Penggerak Motor Listrik Guna Meningkatkan Produktivitas Produsen Keripik Singkong," *Seminar Nasional TEKNOKA*, pp. 14-22, 2020.

[16] R. Sunge, R. Djafar and E. S. Antu, "Rancang Bangun dan Pengujian Alat Pencacah Kompos dengan Sudut Mata Pisau 45 Derajat," *Jurnal Teknologi Pertanian Gorontalo (JTPG)*, pp. 62-70, 2019.

[17] N. E. E. Saputro, A. S. Nurrohkayati and S. H. Pranoto, "Analisis Desain Mesin Pencacah Limbah Organik Sebagai Bahan Dasar Pupuk," *TEKNOSAINS: Jurnal Sains, Teknologi dan Informatika*, vol. IX, no. 2, pp. 101-112, 2022.