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SLAUGHTERHOUSE WASTEWATER IMPROVE NUTRIENT LEVEL IN *APIUM GLAVIOLENS*

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ABSTRACT

The combination between waste-water of slaughterhouse and nitrogen fertilizer to reach the suitable dose in mean relative growth rate were found in *Apium glaviolen*. Growth rapidly of net assimilation rate with sigmoid pattern until 42 days and than growth horizontally. Animal slaughterhouse waste 100 mL/L combined with 0.1 g/kg nitrogen fertilizer/kg soil showed the best treatment for increasing the vegetative growth of *Apium glaviolens*. This is indicated by net assimilation rate and mean relative growth parameters. Growth gradually decrease after 35 days of planting and that time the plants were harvested. Between all vegetative growth parameters has only 100 mL/L slaughterhouse waste combined with applied 0.1 g/kg nitrogen fertilizer showed highest vegetative growth.

KEY WORDS : *Apium-glaviolens*, Nitrogen, Pollutant, Slaughterhouse, Waste

INTRODUCTION

Agriculture and animal product are two industrial sector for economic activities subjected to people welfare. Livestock products as meat and others proportion product go through significantly important as main food material in the food industry. The processing of meat and other raw material appear as wastewater and inevitably emerge as pollutant.

In Indonesia and other developing countries of Asia, the slaughterhouse waste have became one of the new pollutant materials if could not be managed with appropriate techniques, discharged into water bodies like river and other bodies in our environment (Bustillo-Lecompte and Mehrvar, 2015). They are resulted in the production of bigger quantities of waste than at present.

Diverse techniques are applied to slaughterhouse wastewater and many treatment efforts were conducted to acquit pollutant materials like slaughterhouse wastewater to reach fresh water and proper throw into water bodies.

In our location Riau province Indonesia, the wastewater of slaughterhouse were investigated to organic fertilizer as substitution for commercial fertilizer. Preliminary experiment on the vegetable plants have shown that the slaughterhouse wastewater on suitable concentration could increase the net assimilation rate and mean relative growth rate significantly (Jumin, 2017).

This experiments conducted to identify the possible use of the slaughterhouse wastewater to improve nutrient level and could for used for substitution of organic fertilizer in vegetable plants and possible treatment alternatives to minimize the impact of the discharge of these wastewaters to the environment.

MATERIALS AND METHODS

Study area

This research was conducted in the Faculty of Agriculture Islamic University of Riau, Indonesia. Two splits of experiment were conducted to evaluate the slaughterhouse waste, namely the effect of wastewater slaughterhouse to *Apium graviolens* arranged with randomly block design. Number treatment is 16 with 3 replication, therefore total number of unit experiment is 48. First factor of experiment is concentration of wastewater

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slaughterhouse and nitrogen fertilizer. The treatment was arranged per plant as control (0 mL/L), 50 mL/L, 100 mL/L, 150 mL/L, and 0 g nitrogen /kg soil, 0.075 g nitrogen /kg soil, 0.1 g nitrogen/kg soil, 0.125 g nitrogen / kg soil. Second factor of experiment is effect of concentration of animal slaughterhouse wastewater to *Apium graviolens.* The treatment was 0 mL/L, 50 mL/L, 100 mL/L, 150 mL/L. The plants were maintained under light condition with ± 11.45 – 12.15 hour photoperiod

Parameters

Mean Relative Growth Rates (MRGR)

Relative growth rate is the accumulation of dry weight of *Apium glaviolens* during their photosynthesis under light condition. The accumulation of dry weight during the increasing of cell elongation and cell number in *Apium glaviolens*. Mean relative growth rate (MRGR) of *Apium glaviolens* can be calculated to parameter dry plant dry weight on period time. Fist time plant dry weight calculated for *Apium glaviolens* at 7 days (t1) and second time (t2) 14 days period time until at 35 days. The equation for calculating the MRGR(South 1995) is as follows;

$$MRGR=\frac{\ln W2-\ln W1}{t2-t1} \quad .. \textbf{(1)}$$

Where MRGR is mean relative growth rate; W1 and W2 are the dry biomass of *Apium glaviolens*; beginning (t1) at 7 days after planting and end (t2) of the sampling period; and ***ln*** is the natural logarithm. Equation (1) is the most common formula used when comparing relative differences between slaughterhouse waste treatments.

Net assimilation rates (NAR)

The net assimilation rate is the weight of total dry weight per unit area and certain time (t), of *Apium glaviolens.* The NAR calculating four time with (t1) on 7 days after planting and (t2) on 14 days after planting and forth until four time calculating with activities of cellsto increasing dry weight of *Apium glaviolens*. The NAR is draw rate photosynthesis an increase of biomass weight and also based on several parameter and is one of parameter is leaf area of *Apium glaviolens* there its calculated the same time with the parameter for MRGR (t) in all slaughterhouse and N-fertilizer treatments and it is positively correlated with mean MRGR. Net assimilation rate of the photosynthetic efficiency of plants was measured by Vernon and Allison (1963 methods.

Net assimilation rate of *Apium glaviolens* (E) is defined as the net accumulate of dry weight of plants (W) per unit leaf area of *Apium glaviolens* (South, 1995) as presented in equation 2 thus;

$$E=\frac{1}{L}\frac{dW}{dt} \quad .. (2)$$

The plant is destroyed after dry weight calculated. After ward W is calculated by random sampling from all plants of *Apium glaviolens.* In this experiment samples are examined at intervals 7 days form calculating W and L in during vegetative growth. The W and L means may then be used to accumulate E_M, an estimate of the mean E for each time- interval ($t2–t1$), usually as proposed by Vernon and Allison (1963) and shown in equation 3 thus;

$$E_{M}=\frac{(W2)-W1)\,(Log\ e\ L2-Log\ e\ L1)}{(T2-T1(L2-L1)} \quad .. (3)$$

Leaf area

Leaf area parameter calculated by leaf area meter and image analysis software. Leaf area was calculated twice; on days 21, 28, 35 dyas after planting. All data collected were analyzed by statistical analyses and presented in graphs and histograms.

Biomass

Biomass is biological material derived from plant and is measured at the end of the experiment (Biomass Energy Center, 2012). Chemical contents of wastewater were analyzed with appropriate procedures at the Laboratory of Agro-technology, Faculty of Agriculture, Islamic University of Riau Indonesia. Nitrogen, phosphorus, calcium, pH and heavy metals (Pb, Cu, Ar, Cd and Zn) contents were analyzed at the Kimpraswil Riau. Province Pekanbaru, PT. Central Alam Resources Lestari (Central Plantation Services) and PT. Scupindo Pekanbaru Laboratories.

Dry Weight

Dry weight of plants were measured 4 times during plants life cycle. Dry weight was used as a component to evaluate the mean relative growth rate and net assimilation rate. The dry weight was calculated at beginning since 14 days after planting to soil till 35 days of planting.

RESULTS AND DISCUSSION

Waste water originated from slaughterhouse became important as substitution of pollutant material to environment in Indonesia. Slaughterhouse activities is always drop their waste water to cutter. This material has been accumulated gradually in the water bodies like river and lake and appearing as a serious problem to the environment.

Slaughterhouse waste may contain nutrient and organic substances which make biological process and becoming as substitution nutrient to plant growth. Oxidation processes are resulted to depredates of the wastewater containing blood and remains of the meat or pieces of animal (minority cow) and its could improve the bioprocess and degradation of the bio-material in wastewaters. Some of slaughterhouse wastewater, are toxic to water bodies.

Various estimates of growth process over a period of time can be derived from primary growth data. The estimates of mean relative growth rate has only became one of the proportion for make consideration to growth processes. This resulted data usually appears to have considerable biological importance and can also be used in the accurate determination of the mean unit leaf rate, i.e net assimilation rate (Jumin *et al*., 2016; Jumin *et al*., 2014).

MRGR of *Apium glaviolens* after treatment with slaughterhouse waste and nitrogen fertilizers is presented in Table 2. The chemical analyses of slaughterhouse waste are presented in Table 1 and slaughterhouse was tephysically shown in Figure 1.

Treatment of 200 mL/L of slaughterhouse was combined to nitrogen fertilizer 1.5 g/ polybag

Fig. 1. Fresh slaughterhouse (about 90% cow blood) waste taken from slaughterhouse Pekanbaru (left) and *Apium glaviolens* at 35 days after planting to soil with 100 ml/L slaughterhouse and 0.1 g nitrogen fertilizer/kg soil (right).

Table 1. Nutrition content of Slaughterhouse waste

Material	Compound	Value (ppm)
Cow Blood	Nitrogen total	25.7
	Phosphorus total	196
	Potassium	608
	Magnesium	107

significantly increased average mean relative growth rates (Table 2). Dry weight of increased from 1.83 g to 3.47 g (Fig. 3). The relative growth rate of *Apium glaviolens* rapidly growing until 35 days and growing horizontally until the end of the harvest time period (Jumin *et al.*, 2016) mentioned the crude palm oil liquid sludge sewage was treated to maize with 400 cc/plant could be increased mean relative growth rates, net assimilation rate, leaf area and dry weight of seed. There are indicated that 200 mL/L polybag of slaughterhouse treated to *Apium glaviolens* significantly increase the average of growth of plants and net assimilation rate (Fig. 2) increased by addition of fly ash sewage on maize (9) and seed dry weigh was also increased by addition of fly ash sewage on the four soybean varieties (Jumin *et al*., 2017). Biomass of *Apium glaviolens* were increased by addition of suitable dose of slaughterhouse waste combined with nitrogen fertilizer (Fig. 3).

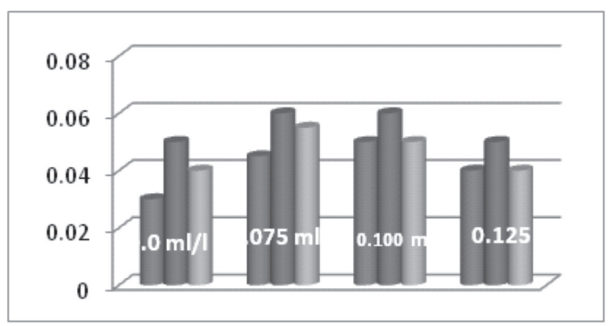

Fig. 2. The effect of slaughterhouse waste on Net Assimilation Rate (mg^{-1}.m^{-2}. days^{-1} of *Apium glaviolens* 14, 21, and 28 days after days planting to soil.

The accumulated of growth rate recorded in a unit of time is a percentage of the size of *Apium glaviolens* the early of the period and this percentage changes as the plant increases in size; often the percentage declines as size increases. The *Apium glaviolens* show a higher MRGR on treatments with slaughterhouse waste combined with 1.5 g/polybag of nitrogen fertilizer. Studies on field crop showed that the MRGR of *Apium glaviolens* differed between doses treatments of crow blood waste and nitrogen fertilizer.

Some treatments caused a slight increase in dry weight and it was difficult to identify differences in other slaughterhouse waste treatments. However, comparing MRGR of slaughterhouse waste treatments to the control treatment is easier and significantly different. The difficulties in calculating the lower MRGR caused difficulties in measuring biomass dry weight of plants (South, 1995) and other case was also showed to maize MRGR by addition of fly ash (Jumin *et al*., 2016).

Many vegetables plants exhibit a declining mean relative growth rates over time of vegetable plant. In such slaughterhouse waste cases, neither the instantaneous relative growth rates nor the mean relative growth rates are independent of size. The NAR of vegetable plants, or unit rate of plant increases total dry weight per unit area measured over a period of one week, represent in excess mean rate of photosynthesis of the leaves over the mean rate respiration of the whole plant (Watson and Hayashi, 1965), both expressed per unit leaf area. The NAR is based on an increase in plant biomass weight and leaf area over a fixed time of plants, and it is positively correlated with mean Nutrient content of the slaughterhouse chemical analysis could be shown in (Table 1). Dry weight is a value that relates plants productivity to plant size. Dry weight is obtained by dividing the rate of increase in plant growth and other parameter and its also by leaf size (leaf area).

With full utilization of the nutrient content in treated sewage sludge, it would prove significant in reducing cost in fertilizer acquisition while minimizing overall disposal of solid wastes into landfills or incinerators. Based on chemical analysis of slaughterhouse waste, it is shown that its materials do not exceed the threshold content of dangerous metals and biological effects. Therefore, it

Table 2. Mean relative growth rates (MRGR) slaughterhouse waste and N Fertilizer

Treatments		N Fertilizer (g/kg)				
Slaughterhouse (mL/L)	MRGR	0.0	0.075	0.100	0.125	Average
0.0	MRGR 3rd weeksg.day^{-1}	0.090	0.160	0.205	0.143	0.150 c
50		0.125	0.188	0.220	0.177	0.178 b
100		0.148	0.220	0.245	0.193	0.202 a
150		0.113	0.150	0.230	0.182	0.169 b
Average	Average	0.119 c	0.180 b	0.216 a	0.174 b	
0	MRGR 4th weeks g.day^{-1}	0.090	0.160	0.205	0.143	0.150 c
50		0.125	0.188	0.220	0.177	0.178 b
100		0.148	0.220	0.245	0.193	0.202 a
150		0,113	0.150	0.230	0.182	0.169 b
Average	Average	0.119 c	0.180 b	0.216 a	0.174 b	
0.0	MRGR 5th weeks g.day^{-1}	0.190	0.237	0.302	0.220	0.237 d
50		0.212	0.267	0.310	0.273	0.266 c
100		0.320	0.370	0.395	0.317	0.350 a
150		0.280	0.297	0.332	0.297	0.302 b
Average	Average	0.251 c	0.293 b	0.321 a	0.277 b	

Mean value followed by different alphabet/s within column do not differ significantly over one other at $P \leq 0.05$ lead by Duncan's Multiple Range Test

Table 3. Dry weight of *Apium glaviolens* after treated with slaughterhouse waste combined with N fertilizers

Slaughter house	N Fertilizer(g/kg)				Average
waste (cc/L)	0.0	0.075	0.100	0.125	
0.0	1.03	2.07	2.32	1.82	1.81 c
50	1.53	2.53	3.22	2.43	2.43 ab
100	1.80	3.17	3.47	2.43	2.72 a
150	1.43	2.54	2.27	2,90	2.29 b
Average	1.45c	2.58 ab	2.82 a	2.40 b	

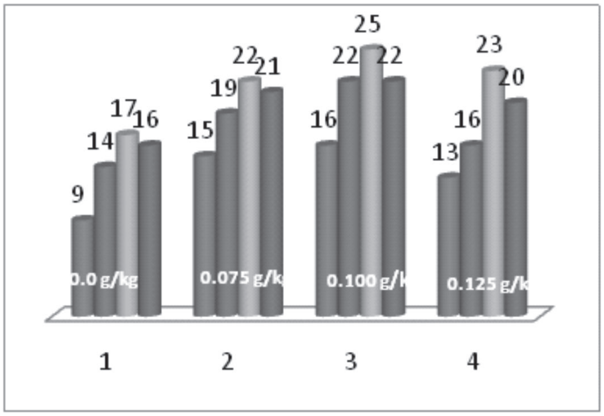

Fig. 3. Biomass of *Apium glaviolens* after treated with slaughterhouse waste and N fertilizer

has no effect on human body. After processing the slaughterhouse waste in the factory, it is disposed in reservoir or accumulated in lands.

The remaining chemical products in Slaughterhouse waste can be used to modify pollutants that increase the removal of these new forms by physical and physiological processes. Slaughterhouse has no heavy metal contents (Table 1) like mercury, arsenic, cadmium, chromium, cobalt, lead and molybdenum can be deposited on land or in water bodies causing certain pollutants like other organic compounds to bind together into large, heavier masses which can be removed faster through physical processes.

Slaughterhouse wastewater content of essential nutrition (nitrogen, phosphorous and calcium) suggests their can use a as fertilizer in agriculture. Nitrogen and other essential nutrition can promote the NAR, MRGR and other vegetative growth parameter. Therefore although its slaughterhouse wastewater but its capable to used as alternative organic fertilizer.

CONCLUSION

Slaughterhouse waste originated from the slaughterhouse industry affected to promote the growth of *Apium glaviolens* and resulted the high biomass of the plants. The increase in the vegetative biomass of *Apum glaviolens* caused the slaughterhouse waste containing essential nutrient and their important to promote the growth of the plants. Therefore slaughterhouse waste could be applied to plant and to be used as substitution of organic fertilizer.

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