RESEARCH ARTICLE

POTENTIAL FOR PRODUCING STANDARD COMPOST FROM BEEF CATTLE AND CORN WASTES

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Manuscript Info	Abstract

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The success of the corn agro-industry is greatly influenced by fertilizeravailability. A notable effort to support that situation is to increase compost production through the utilization and processing of beef cattle and corn wastes. Thisresearch proposed to produce compost from the utilization of beef cattle and corn wastes by following the Indonesian National Standard (SNI). The composting process was carried out by preparing several materials consisting of beef cattle manure (BCM), wet/dry stover (WS/DS), and EM4 solution. These materials were fermented anaerobically, then checked and stirred every three days.The fermentation was stopped after 40 days. This study used a Randomized Block Design (RBD) consisting of five levels of compost materials treatments, namely P0, P1, P2, P3, and P4, with three replications. The parameters observed were the characteristics of cattle and corn waste, the physical feature of the compost, and the nutrient content of the compost (yield, water content, pH, P_2O_5, K_2O, organic C, total N, and C/N ratio). P2 treatment (BCM:WS:DS:EM4 =1:2:1:1) produced compost with the best characteristics, namely blackish brown color and crumbly with slightly sour aroma. The yield obtained was 32.95%, water content was 10.08%, pH was 5.59, $P_2O_5$was 0.50%, K_2O 1.26%, organic C was 52.34%, total N was 1.34% and C/N ratio was 39.06. These characteristics are by following under the SNI; cheap, practical in manufacture and application in the field, and environmentally friendly.

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Introduction:-
Domestic demand for corn has increased significantly. Besides being used to procure food and feed, corn is also widely utilized in the food, beverage, chemical, and pharmaceutical industries which will provide added value for its commodity farming [1]. Based on data from Statistics Indonesia, Indonesia's corn production in 2016 reached 23.58 million tons of dry flakes. The production increased in 2017 to 28.9 million tons and 30 million tons in 2018 [2].

However, various problems are faced in the corn agro-industry development such as low productivity, fluctuating corn prices, smaller land area, higher production input prices, and the risk of crop failure due to weather changes. Its success is greatly influenced by fertilizer availability. Until now, most corn farming businesses still use artificial fertilizers, although the availability of this fertilizer continues to decrease. The use of this fertilizer type also has an

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impact on the ecological balance so that the carrying capacity of the environment continues to be degraded. As a result,corn productivity gets lower.

Most by-products of beef cattle and corn are wasted. In addition to their pungent smells, they are also sources of disease. This is quite unfortunate as the number of by-products produced is high, and they have the potential to be utilized as a source of raw materials for making organic fertilizers [3].

Beef cattle dung or manure can be in the form of mud which is a combination of its pure manure with rainwater, washing water, and feed. Beef cattle raised by farmers are usually given more forage than concentrate so that their feces contain a lot of fiber [4]. The characteristics of beef cattle waste such as feces and its amount are determined by the cattle type, age, and physical form, feed and water provided, climate, fattening type, management method, andcattlefeed digestibility [5]. Beef cattlemanure contains cellulose, hemicellulose, lignin, organic carbonates, nitrogen, phosphorus, and potassium so that it is made into compost with beef cattle solid waste materials containing cellulose. Cattle manure is a good source of soil nutrients such as nitrogen of 2-8.1 g/kg, phosphorus of 7.89 g/kg, potassium of 38.45 g/kg, sulfurof 0.054 g/kg, and magnesium derivatives of 0.028 g/kg from livestock rations and other elements [6][7].

Corn waste production for one year depends on the corn harvested area in the form of stover and cobs which are usually abundant. Stover consists of stems and leaves that are left in the field after being harvested to produce wet or dried fruit for the needs of the feed industry. Stems are the main component with a percentage of 50%, leaves of 20%, cobs of 20%, and corn husks of 10% [8][9][10]. The average weight of corn stover was 0.46 kg/plant or equivalent to 15,508.9 kg/ha per one planting [11]. The utilization of corn stover as a source of organic matter cannot be applied directly as the decomposition process was slowed. Thus, bio-activator EM4 can be utilized to accelerate composting [12].

One of the various alternatives is to increase the production of organic fertilizer (compost) through the processing of beef cattle and corn by-products with proper fermentation techniques. Thisresearch proposed to utilize beef cattle and corn wastes to produce compost that met SNI, namely cheap, practical in manufacture and application in the field, and environmentally friendly.

Methods:-
Research Location and Period
This research was conducted in Deli Serdang Regency, North Sumatra Province, and the Faculty of Agriculture, the Islamic University of North Sumatra from June to September 2019.

Research Materials and Tools
The raw materials used in this study were beef cattle manure (BCM) in the form of a mixture of feces, urine, and animal feed residues; corn waste in the form of the wet stove (WS), dry stove (DS), and EM4 solution. The research tools used included tissue paper, label paper, polybags, plastic buckets/tubes, mixers, chopping machines, grinding machines, ovens, kilns, micropipettes, analytical balances, Whatman 1 filter paper, desiccators, and other analytical tools.

Research Stages
The stages of composting were performed with the following steps: the materials utilized were prepared by collecting and bringing BCM from the livestock pens to the greenhouse, collecting and calculating WS/DS using a 3-5 cm chopper machine, making 1% of EM4 solution (10 ml/1liter of water v/v). Furthermore, a composting container consisting of a 50 x 50 cm hollow polybag and a plastic bucket with a capacity of 18 kg was also prepared.

The BCM material was weighed and mixed with the chopped WS/DS and EM4 solution according to the treatment (P0, P1, P2, P3, and P4). It was then stirred evenly in a plastic bucket, starting from the ingredients in large quantities to small amounts until it was homogeneous. Composting was carried out in an anaerobic system using EM4 with the hope that the process could run faster [13]. The homogeneous material was put into a perforated polybag in a plastic bucket tobe then tightly closed. During the decomposition process, stirring/reversing was done once every three days.

The compost was harvested after 40 days ofthe decomposition processas it was estimated that it was ripe-marked by no longer emitting a foul and pungent smell (a typical fermented smell). The ripe compost was dried in the sun and periodically inverted to dry (about three days). The dry compost was finely ground (40-60 mesh sieve) and then packed.

Experimental Design
The experimental design in this study used a Randomized Block Design (RBD) which consisted of five compost treatments and three replications. The composition of the treatments is presented in Table 1. For comparison, the compost produced is Compost Quality Standard (SNI 19-7030-2004) and compost produced on the market ("Reksa/Kospi (R/K)" PercutSei Tuan compost).

Table 1:- The composition of treatments.

No	Treatments	Materials
1	P_0	4 kg of BCM + 1 ofEM4 solution of 1%
2	P_1	1 kg of BCM + 3 kg ofWS + 1 l ofEM4 solution of 1%
3	P_2	1 kg ofBCM + 2 kg ofWS + 1 of kg DS + 1 l of EM4 solution of 1%
4	P_3	1 kg of BCM + 1 kg ofWS + 2 kg of DS + 1 l of EM4 solution of 1%
5	P_4	1 kg of BCM + 3 kg of DS + 1 l of EM4 solution of 1%

Parameter Measurement
Observations made in this study were in the form of physical properties and characteristics of the compost produced. Observation of the physical form of compost, namely changes in color, texture, and smell of compost. Observation of compost characteristics was carried out by analyzing the nutrient content of composting at the Indonesian Palm Oil Research Institute Medan (PORIM) including yield and water content determined by the oven method (AOAC: SNI 19-7030-2004), pH with potentiometry (AOAC: SNI 19-2004). 7030-2004), P_2O_5 was measured using spectrophotometry (AOAC:SNI 19-7030-2004), K_2O was measured using AAS (Atomic Absorption Spectroscopy) (AOAC:SNI 19-7030-2004), organic C was measured by gravimetric method (AOAC: SNI 19-7030-2004), total N using the volumetric method (AOAC:SNI 19-7030-2004), and calculating the C/N ratio of compost.

Data Analysis
Data analysis in this study wasthe analysis of variance (ANOVA). Based on the data analysis, if a significant difference is obtained from the treatment, then a further test is carried out with Duncan Multiple Range Test (DMRT) at a level of 1% [14].

Results And Discussion:-
Compost Physical Features
Composting was a biological activity by microbes that convert and decompose organic matter into compost under controlled conditions. The results showed that anaerobic composting caused changes in the physical form of the compost (color, texture, and smell). Compost quality is determined by microbial activity in the composting process and microbial activity is influenced by several factors, namely raw materials, nutrient composition, humidity, temperature, pH, and aeration [15]. The results of observing the physical form of compost after 40 days based on its materials are presented in Table 2.

Table 2:- The physical form of compost based on its materials.

Parameter	[15]	R/K Compost	Treatments of Compost Materials				
			P_0	P_1	P_2	P_3	P_4
Color	Black	Black	Black	Blackish brown	Blackish brown	Brown	Brown
Texture	Crumbly	Crumbly	Crumbly	Crumbly	Crumbly	Slightly crumbly	Slightly crumbly
Aroma	Soil	Sour	Sour	Sour	Sour	Sour	Sour

Table 2 demonstrated that the 40-days-composting process produced black compost at P0, blackish-brown at P1 and P2, and brown at P3 and P4. This exemplifies that the composting process was going well, marked by changes in color, where the brownish-green color changed to dark brown. At the end of the composting process, it turned brownish-black due to the formation of humic acid. The composting process is considered complete and the compost is ripe if the compost is black. The composting speed depends on the basic ingredients. The color changes might be caused by microbial activity that works during the decomposition process [16][17]. That blackish browncolor of the compost has met the standard (SNI 19-7030-2004).

The composting process is characterized by changes in the texture of the compost base materials. Based on observations, it is known that the P0, P1, and P2 treatments have a crumbly texture. Meanwhile, P3 and P4 have a slightly crumbly or rough texturepresumably because the dominant raw material used is dry stover. This information is in line with previous research [18], stating that the fermentation process by bacteria is more perfect if the material used is in the form of plant waste that is still green or has not yet dried. The compost material decomposes evenly and does not resemble the shape of the initial composition anymore as, during the composting process, the fermented microbes decompose complex insoluble organic substances (cellulose) into soluble molecules (fatty acids, amino acids, and sugars). From the remaining molecules, fermented microbes then break down simple molecules into acetic acid, carbon dioxide, and hydrogen.

All treatments produce composts that smell slightly sour. In the early stages of anaerobic composting which took place in an oxygen-free environment (closed system), the decomposition of the complex organic compounds into simple compounds could cause a very unpleasant smell due to the release of sulfur-containing compounds such as hydrogen sulfide. However, the sulfursmell is an indication that the decomposition process was in progress. This is supported by the results of research [19],explaining that composting using EM4 on day 15 produced an odor that tended to resemble a sour smell. The intensity and level of odoror smell during anaerobic composting were higher than aerobic composting [20][21]. Mature compost has a soil smell. Thus, the smell of compost from the results of this study is not up to the standard (SNI 19-7030-2004).

Characteristics of Produced Compost
The results of the compost parameter test and the resulting nutrient analysis point out a very significant difference at the 1% level. Decomposition could run optimally and produce compost by following the applicable standards (SNI 19-7030-2004). The results of the compost nutrient analysis are presented in Table 3.

Table 3:- Compost nutrient contents based on the effect of itsmaterials in different with superscript [A,B,C,D]meaning different (P <0,01).

Treatments	Parameter							
	Yield(%)	WaterContent (%)	pH	P_2O_5 (%)	K_2O(%)	Organic C (%)	Total N (%)	Ratio of C/N
[16]	-	50	6.8 - 7.49	0.10	0.20	9.8 - 30	0.40	10 - 20
R/K	50	20	7.30	1.58	1.75	25.69	1.98	23.57
P_0	22.86^C	15.02^C	9.15^D	2.12^D	2.32^C	46.23^A	2.19^B	22.75^A
P_1	12.95^A	28.00^D	5.40^C	0.04^A	1.16^A	52.96^D	1.39^A	38.10^D
P_2	32.95^D	10.08^A	5.59^C	0.50^B	1.26^A	52.34^B	1.34^A	39.06^E
P_3	21.33^B	15.04^C	4.84^B	0.63^C	1.27^A	52.71^C	1.50^A	35.14^B
P_4	34.29^E	13.03^B	4.51^A	0.62^C	1.65^B	52.72^C	1.47^A	35.86^C

Yield
The results of variance analysis show that compostshave a very significant effect (P<0.01) on the yield (Table 3). The average yield of composts is presented in Table 3; the lowest compost yield is atP1 treatment and the highest is at P4. This situation exhibits a significant difference through the DMRT test. Table 3 also implies the yield of composts produced is lower than the yield of R/K compost. R/K compost is made from a mixture of cattle dung, rice husk ash, and dolomite so that the compost yield is higher. This yield variation depends on the decomposition process of the material used, where cellulose is more easily decomposed than lignin. Corn stalks are mainly composed of cellulose (33-45%), hemicellulose (20-30%), and lignin (11-23%) [22][5][23]. High lignin content is difficult to decompose by microbes because lignin is a complex compound so that the decomposition process is

hampered [23]. Anaerobic fermentation with EM4 bio-activator reduces the weight of compost higher than aerobic fermentation because the anaerobic microbial decomposition process converts organic matter more into CO_2, water vapor, humus, and heat. Mature compost shrinks between 50-75% of the compost initial weight [25].

C/N Ratio

The results of variance analysis point out that the treatments of compost materials have a very significant effect (P<0.01) on the C/N ratio (Table 3). The average C/N ratio was lowest in treatment P0 and the highest was in treatment P2. Thisshowed a significant difference through the DMRT test. Based on Table 3, it can be seen that the C/N ratio of the composts produced is higher than the SNI and R/K compost. During the decomposition process of organic matter, the C and N contained in the compost material were used by microbes as an energy source and were the constituent cells. Shorter composting time with lower material C/N ratio.A study [26] explains that compost made from materials such as corn stover, straw, rice husks, and sawdust has a C/N ratio between 50-100. Therefore, a longer composting process is required if the anaerobic method is applied [27]. The C/N ratio of all treatments is still within the range required by the national standard (SNI 19-7030-2004).

Water Content

The results of variance analysis exemplify that the treatments of compost materials have a very significant effect (P<0.01) on the water content (Table 3). The lowest water content is at P2 and the highest is at P1. The water content is lower than the standard of SNI and R/K compost so that it is following the standard (SNI 19-7030-2004). The water content of the compost illustrates that the decomposition process was going well; the decomposition of organic matter into CO_2, steam, and compost was carried out successfully. At the time of composting, the initial moisture content of the material was quite high, obtained from wet/semi-wet cattle manure and corn stover, as well as the addition of 1 liter of EM4 solution. In short, this condition has met the requirements of composting which required initial moisture or water content of about 50% of the material [28].

pH

The results of variance analysis show that the treatments of compost materials have a very significant effect (P<0.01) on the pH (Table 3). The lowest compost pH is at P4 (4.51) and the highest is at P0 (9.15) compared to SNI and R/K compost. During the composting process, water vapor was retained in the compost so that the humidity increased.The compost pores filled with water tended to cause anaerobic conditions and microbes could not grow to reach a neutral pH. The decrease in pH was caused by the release of acid compounds.Otherwise, compounds containing nitrogen would produce ammonia which could increase the pH [27][29]. The pH of the compost produced by all treatments is not up to standard (SNI 19-7030-2004).

P_2O_5

The results of variance analysis point out that the treatments of compost materials have a very significant effect (P<0.01) on the P_2O_5content (Table 3). The highest P_2O_5content isat P0 and the lowest $P_2O_5$is at P1. The P_2O_5content is higher than the standard (SNI 19-7030-2004) and lower than R/K compost. The variations in the compost phosphorus content might be caused by the amount of phosphorus contained in compost materials. When the research was conducted, one of the compost materials used was cattle dung or manure. A study [30] explains that the feces of beef cattle fed with forage feeds has a higher phosphorus content than the feces of animals fed with granules or concentrates. In addition, the N content of the compost is closely related to the P_2O_5. The higher the nitrogen in the compost, the propagation of phosphorus-degrading microbes would increase so that the phosphorus content in the compost would also escalate [25]. The P_2O_5content of the compost from all treatments has met the standard (SNI 19-7030-2004).

K_2O

The results of variance analysis show that the treatments of compost materials have a very significant effect (P<0.01) on the percentage of K_2O (Table 3). The highest K_2O content is at P0 (2.48%) and the lowest is at P1 (1.16%). Here, $K_2O$is higher than the standard (SNI 19-7030-2004) and R/K compost. This condition is possible as the compost materials greatly affect the potassium content of the compost used for bacterial activity. This is confirmed by the statement [4] explaining that potassium (K_2O) is used by microbes as a catalyst in substrate materials that greatly impactthe increase in potassium content. K_2O at all treatments has met the standard (SNI 19-7030-2004).

Organic C
The results of variance analysis exemplify that the treatments of compost materials have a very significant effect (P<0.01) on the organic C (Table 3). The lowest organic C is at P0 (46.23%) and the highest is at P1 (52.96%). The organic C content of the compost is still higher than the quality standardsince the corn stover and cattle dung contain high levels of carbon compounds. Although there was a process of decomposition of organic matter by a microbial activity where most carbons were released in the form of methane gas (CH4), a small part of the carbon was lost or evaporated as CO2. However,high levels of C were also produced [31][20].

N total
The results of variance analysis show that compost materials have a very significant effect (P<0.01) on the total N (Table 3). The lowest total N is at P3 (1.34%) and the highest is at P0 (2.19%). The total N of compost is higher than the standard (SNI 19-7030-2004) but is lower than the R/K compost. This is because cattle manure and corn waste have large amounts of nitrogen associated with protein. Thus, the decomposition of organic matter would produce a lot of nitrogen which is one of the parameters of the compost quality standard. Anaerobic composting was intended to minimize nitrogen loss [29]. Various bacteria broke down proteins and released nitrogen into simpler compounds and finally into nitrates that could be absorbed by plants through the roots [18]. In general, the total N of all treatment combinations has met the standard (SNI 19-7030-2004).

Conclusion And Suggestion:-
Beef cattle and corn wastes can be used as raw materials for producing compost. Compost materials with P_2composition (BCM: WS: DS: EM4 solution = 1: 2: 1: 1) produce compost with physical features of blackish brown, crumbly, slightly sour smell.The compost has a water content of 10.08%, pH of 5.59, $P_2O_5$of 0.50%, K_2O of 1.26%, organic C of 52.34%, total N of 1.34%, and C/N ratio of 39.06. It was more in line with SNI quality standards namely practical in manufacturing and application in the field, as well as environmentally friendly. It is recommended to apply the compost produced on corn plants as a step to support the development of an integrated corn agro-industry.

Acknowledgment:-

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