The Role of Powder *Sub-bituminous* Coal with Sodium Hydroxide (NaOH) to Improve Chemical Properties of Ultisols

Herviyanti [#], T.B. Prasetyo, Juniarti, S. Prima, and S. Wahyuni

Department of Soil Science, Faculty of Agriculture, Andalas University Limau Manis, Padang, West Sumatra, Indonesia
Email : [#]evi.64.faperta@gmail.com

***Abstract*— This research was conducted in soil chemical laboratory, Faculty of Agriculture, Andalas University, from December 2016 until May 2017. The purpose of this research are to determine the level of activeness of powder coal *Sub-bituminous* coal with Sodium Hydroxide (NaOH) and to determine the appropriate dosage of the mixture in improving the chemical properties of Ultisols. This research was conducted in 2 stages: first stage study with 10 treatments (1% to 10% (w/w) NaOH) and the second stage study on soil using 15 treatment combinations (3 doses of powder *sub-bituminous* coal with 5 doses of NaOH). The results of the first stage of research is the addition of NaOH in *Sub-bituminous* to increase the activity of powder *Sub-bituminous* coal with parameters of pH, CEC, and increases the number of O-H, C=O, and CH_3 groups.The results of stage II studies is the provision of a mixture of 20 ton $(ha)^{-1}$ powder *Sub-bituminous* coal and 10% of NaOH were able to increases the pH of H_2O, CEC, organic-C, Available-P, and Total-N Ultisol each of 1.49 units, 28.08 me.100g-1, 1.63 % C, 2.37 ppm P, 0.06% N, and decreases Al-exch Ultisol by 1.17 me.100g-1and , SAR Ultisol by 0.03, and ESP Ultisols by 0.82 % compared to nature soil.**

Keywords : NaOH; Sub-bituminous; Ultisols

I. Introduction

Indonesia is the largest coal producer after china, america, india and Australia. Coal production in Indonesia reaches 470.8 million tons in 2014. Indonesia is the world's largest exporter of coal from 2011 to 2013 [1]. Coal is grouped into four levels, namely (a) *Lignite* (b) *sub-bituminous* (c) *Bituminous* (d) *Anthracite. Anthracite* and *Bituminous* has a high calorific value is > 5,700 kcal $(kg)^{-1}$ so widely used as a fuel. *Sub-bituminous* and *Lignite* contain low calorific value, so they are not suitable as fuel. *Sub-bituminous* type has traits not clot, contains a calorific value of 4,165 kcal $(kg)^{-1}$ to 5,700 kcal $(kg)^{-1}$ (ASTM, 2006; *cit* [2].

[3] Reported that *sub-bituminous* taken from Pasaman, West Sumatra can be used as a source of organic material because it contains humic substances as much as 31.5% (21% humic acid and fulvic acid 10.5%) were extracted with NaOH 0.5 N. *Sub-bituminous* percentage humic acid (21%) was higher than the percentage of humic acid contained from other organic materials, such as municipal solid waste compost (1.4%), manure (1.6%), rice straw compost (5%), and peat soil (9.2%) [4]. Therefore, *sub-bituminous* as a source of humic substances can be used as soil organic matter to improve soil fertility.

[5] explains that soil organic matter is the source of organic compounds that can be absorbed even in small amounts. Chemically, organic matter acts as a contributor to the amounts of nutrients ions available which are the result of the mineralization processes of the decomposable parts of the organic material; because the soil organic matter has a large specific surface area of about 800-900 m^2g^{-1} so that the Cation Exchange Capacity (CEC) of soil organic matter becomes high that is about 150 - 300 cmol / kg. CEC is high on soil organic matter able to absorb many cations so that both micro and macro nutrients will be met [6].

Humic matter is the organic material components that rapid reaction, most active in the ground with electric charge and cation exchange capacity (CEC) which is greater than the clay mineral [7]. Control of Al and Fe toxicity and increase the availability of P with the provision of humic materials can occur through the formation of a complex organo-metallic compounds or chelate, so the activity of metal Al and Fe which normally, binding P in the soil can be reduced and there is no toxic for plants. Directly humic matter can improve soil fertility by altering the physical conditions, chemical, and biological soil. Humic materials can modify medium of plants grow, which are increasing the formation of soil structure, increase soil water holding capacity and soil CEC [8].

The presence of humics in soil is necessary for sustainable agriculture, due to their ability to condition the soil, enhance its stability and increase its resistance to erosion, ensure enhanced biological activity and obtain higher crop yields. In addition, humics have the ability to sequestrate soil pollutants, and may be used in soil remediation. Among many other roles, solid HS act as pH buffers and metal binders, and they are places to sequester plant hormones, fertilizers, nutrients, pollutants, and soil toxins [9].

Components of organic materials that play a role in the process of improving soil chemical properties are humic substances [6]. Humic substances are the end result of decomposition of organic matter in the soil which can be obtained by dissolving the organic material with a solvent inorganic such as hydrochloric acid (HCl), fluoride acid (HF), boric acid (H_3BO_3), sodium hidroxyde (NaOH), sodium carbonate (Na_2CO_3), sodium fluoride (NaF), sodium polyphosphate ($Na_4P_2O_7$), sodium-EDTA (Na_2-EDTA), and sodium tetraborate ($Na_2B_4O_7$).various solvents which have been used, the most effective NaOH has the ability to separate materials in the soil humic quantitatively [10].

Sub-bituminous utilization method can be applied easily by the farmers. [11] have examined the use of *sub-bituminous* in two forms, *sub-bituminous* powder and humic substances were extracted from *subbituminous.* The results explain that the ability of *sub-bituminous* powder similar to the ability of humic substances in improving soil chemical properties and soil fertility. So, the use of subbituminous powder is more practical than the use of humic material extracted with 0.5 N NaOH.

NaOH can be used as a chemical agent of *Sub-bituminous* powder so that the chemical properties of the *Sub-bituminous* powder get better. Such as [10] research which has proven that NaOH can increase pH, CEC, C-organic, N-total, P-available and lower exch-Al. So that *Sub-bituminous* powder can improve the chemical properties of marginal soil. It can be concluded, the use of powdered *sub-bituminous* more practical to improve marginal soil chemical properties such as Ultisol.

Ultisol is one type of soil in Indonesia which has an area of about 45,794,000 ha or about 25% of the total land area of Indonesia. Ultisol with a large coverage area has the potential to be used as an agricultural area in Indonesia, for example is Ultisol in Dharmasraya District which has a wide potential to be used as agricultural land. However, in its utilization is faced with several characteristics that can inhibit the growth of plants [12]. Some of the common obstacles in Ultisol are low pH (<4.5), high Exchangeable Aluminum (Al-exch) (2.94 me.$100g^{-1}$, poor macro nutrient content, especially Phosphorus (P), 52-60% P is absorbed by Al, Cation Exchange Capacity (CEC), Potassium (K), Calcium (Ca), Magnesium (Mg), and low organic matter.Such characteristics may affect plant growth and production so that intolerant crops will be hampered by growth and productivity [13].

II. THE MATERIAL AND METHOD

This research was conducted in December 2016 until May 2017 at Soil Laboratory, Faculty of Agriculture, Andalas University, Padang consisting of 2 stages. The first stage experiment aims to select the treatment to be used on the soil experiment (stage II). This study used the Completely Randomized Design (CRD) method with 10 treatments and 2 replications that A = 1% of NaOH; B = 2% of NaOH; C = 3% of NaOH; D = 4% of NaOH; E = 5% of NaOH; F = 6% of NaOH; G = 7% of NaOH; H = 8% of NaOH; I = 9% of NaOH; J = 10% of NaOH/100 g *sub-bituminous).*

Second stage trial used a selected mixture of powder *subbituminous* from first stages and tested in CRD with 15 treatments and 2 replications that A= 10 tons.ha^{-1} *Sub-bituminous* + without NaOH; B= 10 tons.ha^{-1} *Sub-bituminous* + 2.5% of NaOH; C = 10 tons.ha^{-1} *Sub-bituminous* + 5% of NaOH; D = 10 tons.ha^{-1} *Sub-bituminous* + 7.5% of NaOH; E = 10 tons.ha^{-1} *Sub-bituminous* + 10% of NaOH; F= 20 tons.ha^{-1} *Sub-bituminous* + without NaOH; G= 20 tons.ha^{-1} *Sub-bituminous* + 2.5% of NaOH; H = 20 tons.ha^{-1} *Sub-bituminous* + 5% of NaOH; I = 20 tons.ha^{-1}*Sub-bituminous* + 7.5% of NaOH; J = 20 tons.ha^{-1}*Sub-bituminous* + 10% of NaOH; K= 30 tons.ha^{-1} *Sub-bituminous* + without NaOH; L= 30 tons.ha^{-1} *Sub-bituminous* + 2.5% of NaOH; M = 30 tons.ha^{-1} *Sub-bituminous* + 5% of NaOH; N = 30 tons.ha^{-1} *Sub-bituminous* + 7.5% of NaOH; O = 30 tons.ha^{-1}*Sub-bituminous* + 10% of NaOH.

Sub-bituminous taken from the District Pasaman, West Sumatra and then crushed into a powder and sieved with a fineness of 300 mesh sieve. Ultisol was taken from Dharmasraya compositely. NaOH was given aquades of field capacity and then mixed into powder coal *Sub-bituminous*, then incubated for 10 days. After that, it was analyzed in the laboratory. The results of the analysis stage I was chosen mixture is obtained 5 dosage, they are NaOH 0% (without NaOH), 2.5%, 5%, 7.5%, and 10% and mixed with *subbituminous* powder with appropriate treatment dose and incubated 10 days. After that, the mixture of *subbituminous* powder and NaOH is blended with soil, ordered Ultisol (500 g) in each treatment pot, mixed and incubated for 10 days and then analyzed in the laboratory.

The parameters were observed in the trial stage I is (1) pH (H_2O), (2) CEC (3) analysis of functional groups using FTIR spectroscopy *(Fourier Transform Infra Red)* using the correlation table infrared spectra of coal by [14] *cit* [15]. The parameters in the stage II is (1) Organic-C *(Walkley and Black),* (2) Total-N *(Kjeldahl)* (3) CEC *(leaching with NH_4OAc)* (4) Al-exch *(volumetric),* (5) Available-P *(Bray II)* (6) pH H_2O (*elektrometric*) (7) *Sodium Adsorption Ratio* (SAR), the *Exchangeable Sodium Percentage* (ESP), and (8) Electrical Conductivity (EC). The data obtained were analyzed statistically by F test, if F calculated is greater than F Table at 5% level followed by the test of LSD test at 5% level.

III. RESULTS AND DISCUSSION

A. Results of Stage I Research Analysis

1) pH H2O (1:1), and CEC of powder *Sub-bituminous :* Effect of NaOH on pH H_2O (1:1) *subbituminous* powder that has been incubated for 10 days is presented in Table 1.

TABLE 1
EFFECTS OF NAOH TO PH AND CEC OF *SUB-BITUMINOUS* POWDER

NaOH (%)	pH (H_2O)	CEC
	Units	me.100g^{-1}
0	5.34	24.39
1	7.14	39.22
2	7.82	57.48
3	9.41	67,76
4	9.83	91.43
5	10.34	102.60
6	10.54	110.08
7	11.16	119.88
8	11.88	128.34
9	12.45	135.46
10	12.65	148.20

Table 1 showed that NaOH is able to raise the pH H_2O (1:1) of S*ub-bituminous* powder. Giving NaOH at 10% (w/w) is a best treatment in increasing the pH powder S*ub-bituminous* amounting to 7.31 units compared without NaOH. Increasing pH occurred with increasing doses of NaOH are given in *subbituminous* powder caused by NaOH which is an alkaline compound that can donate hydroxide ions (OH^-) so that the concentration of OH^- in *Sub-bituminous* powder increase and result in the pH increases.

Table 1 also showed that with the aexchition of NaOH in powder S*ub-bituminous* cause CEC value also increased. NaOH at a dose of 10% (w/w) was able to increase the best CEC value by 123.81 me $(100g)^{-1}$ compared without NaOH. CEC of powder S*ub-bituminous* increased due to the humic acid contained in the powder *subbituminous* undergo deprotonation, namely the release of H^+ ions functional groups of humic acid at pH 9 will lead to the release of H^+ ions from a phenolic hydroxyl group thus increasing the negative charge which results in increased CEC of powder S*ub-bituminous* [9].

2) *Spectrum FTIR of Sub-bituminous* Powder : FTIR results showed that *Sub-bituminous* Powder has a major absorption band at 3300 cm $^{-1}$ numbers (OH), on the wave of 1637 cm^{-1} (C = O) conjugated strong, at a wavelength of 996 cm^{-1}(aliphatic ethers, alcohols). FTIR results on powder coal *Sub-bituminous* and 3% NaOH (blue), similar in functional groups than the FTIR results powder coal *Sub-bituminous*, but provision the 6% NaOH in powder coal *Sub-bituminous* higher absorption intensity at a wavelength of 3350 cm^{-1} and 1635 cm^{-1} which is becoming identifier OH groups and C = O and the appearance of an absorption band at a wavelength of 1388 cm^{-1} which is becoming identifier CH_3.

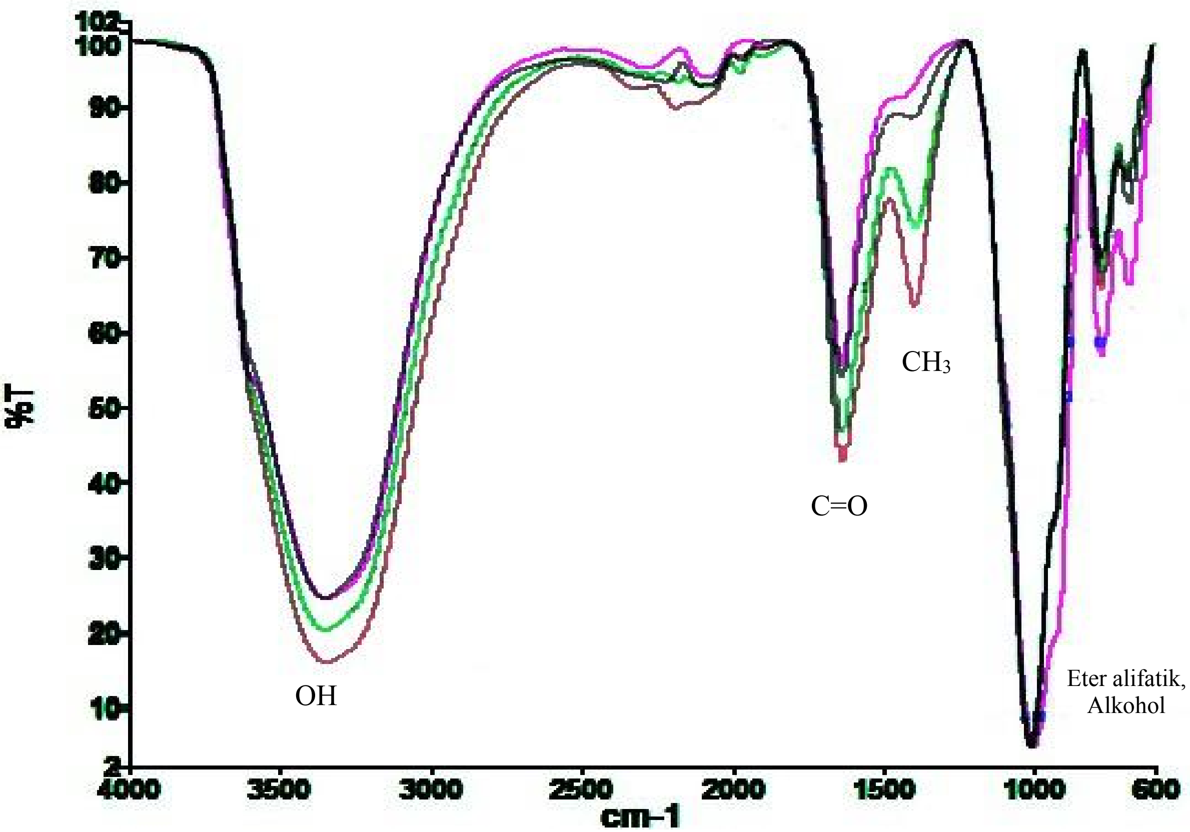


Figure 1. FTIR of powder coal *Sub-bituminous* (purple), 3% of NaOH + powder coal *Sub-bituminous* (blue), 6% of NaOH + powder coal *Sub-bituminous* (green), and 9% of NaOH + powder coal *Sub-bituminous* (red)

Giving a 9% NaOH uptake powder coal *Sub-bituminous* OH, C = O, and CH_3 increasingly intense that characterize the increased activity of powder coal *Sub-bituminous* . It is also characterized by an increase in pH and CEC of powder coal *Sub-bituminous*. According [16], the emergence or increase the absorption intensity group containing a double bond or oxygen-containing group indicates that there has been an increase in the absorption capacity of powder coal *Sub-bituminous*. Increased absorption occurs is the group C=O and OH which is a group that is active in chemical reactions in the soil.

B. Soil Analysis Result

TABLE 2
ANALYSIS RESULT OF CHEMICAL PROPERTIES OF ULTISOL NAGARI KAMPUNG SURAU, PULAU PUNJUNG, DHARMASRAYA, WEST SUMATERA INDONESIA

Chemical characteristics	Value	Criteria
pH	4.36	Very acid*
Al-exch(me.100g^{-1})	2.26	-
CEC (me.100g^{-1})	11.34	medium *
Total N (%)	0.03	Very low *
Organic C (%)	0.95	Very Low *
Available P (ppm)	9.74	low *
Na-exch(me.100g^{-1})	0.11	low *
Ca-exch(me.100g^{-1})	0.15	Very low *
Mg-exch(me.100g^{-1})	0.12	Very low *
SAR	0.31	normal ***
ESP (%)	0.66	Very low **
EC (dS.m^{-1})	1.02	Very low **
pH	4.36	Very acid*
Al-exch (me.100g^{-1})	2.26	-

Table 2 showes that Ultisols have low fertility with soil pH parameters that are very acid, CEC is included moderate criterion, Total-N, Organic-C, Ca-exch, Mg-exch, ESP and EC Which is very low and Available P as well as low Na-exch. This is due to the high rainfall resulting in alkaline minerals leached and decomposition of aluminum silicate in the form of Al^{3+} ions are free to be sequestered in the soil colloids and hydrolysed so that it will donate H^+ ions. This causes the soil to become acidic. The high Al saturation level in Ultisol also causes P-available in the soil to be low due to the occurrence of P fixation by Al. The content of N-total and organic-C in the soil is very low because leached N in the form of NO_3^-(nitrate) caused by rainfall quite high during the formation of soils resulting in leached of bases cations intensively [17].

C. Soil Analysis After Incubation

1) *pH H_2O (1:1) and Al-exch Ultisol* : Giving of powder coal *Sub-bituminous* that was mixed with NaOH provides highly significant effect on pH H_2O (1: 1) and Al-exch of Ultisol. In general, the more powder coal *Sub-bituminous* and NaOH so higher pH of the soil and the lower Al-exch of soil. The provision of 30 tons.ha^{-1} of S*ub-bituminous* and 10% of NaOH is the best treatment that can improve the pH value of 1.84 units and decreased Al-exch of 1.27 me (100 g)$^{-1}$ compared with the provision of treatment to 10 tons.ha^{-1} of S*ub-bituminous* without NaOH. Results of Ultisol chemical analysis results are presented in the Table 3.

TABLE 3
EFFECT OF POWDER COAL *SUB-BITUMINOUS* AND NAOH TO PH AND AL-EXCH OF ULTISOLS

Sub-bituminous Powder + NaOH	pH (unit)	Al-exch (me.100g^{-1})
10 ton.ha^{-1}+ 0%	4.60 j	1.90 a
10 ton.ha^{-1}+ 2.5%	5.09 hi	1.45 abcd
10 ton.ha^{-1}+ 5%	5.25 gh	1.35 abcde
10 ton.ha^{-1}+ 7.5%	5.33 fgh	1.14 bcde
10 ton.ha^{-1}+ 10%	5.67 def	0.93 de
20 ton.ha^{-1}+ 0%	4.60 j	1.79 ab
20 ton.ha^{-1}+ 2.5%	5.32 fgh	1.35 abcde
20 ton.ha^{-1}+ 5%	5.80 cde	1.03 cde
20 ton.ha^{-1}+ 7.5%	6.03 bcd	0.93 de
20 ton.ha^{-1}+ 10%	6.09 abc	0.73 de
30 ton.ha^{-1}+ 0%	4.69 ij	1.67 abc
30 ton.ha^{-1}+ 2.5%	5,56 efg	1.25 abcde
30 ton.ha^{-1}+ 5%	6.15 abc	0.93 de
30 ton.ha^{-1}+ 7.5%	6.21 ab	0.73 de
30 ton.ha^{-1}+ 10%	6.43 a	0.63 e
CV	1.80%	15.59%

The numbers followed by the same lower case are not significant at the 5% level according to LSD

Based on the stage I trial that adding NaOH to increase the pH *subbituminous* powder of up to 7.31 units so that the pH *subbituminous* be 12.65 units for their cargo OH^- resulting in a pH increase. With the provision of materials that have an alkaline pH will certainly increase the soil pH. Ultisol pH increase also caused due to the use of powdered *subbituminous* which produce organic acids (humic acid and fulvic acid) which can form complexes with Al^{3+} and hydroxide ions (OH^{-}) derived from the ionization process NaOH were able to neutralize the hydrogen ions (H^+) so that the pH soil increases.

Giving *subbituminous* powder which has been mixed with NaOH has a significant effect on the content of exch-Al Ultisol. The best treatment was administered 30 tons / ha of *Sub-bituminous* powder mixed with 10% NaOH which reduced exch-Al by 1.28 me / 100 g. the decrease in exch-al content is caused due to humic acid contained from the *Sub-bituminous* powder of Al ion fixation so that Al is no longer soluble, as the following reaction :

$$Al^{3+} + RCOO^- \rightarrow Al(RCOO)_3$$

The reaction shows that Al^{3+} ions can be fixed by organic material so that Al^{3+} ion does not dissolve and settle.

2) Organic-C and Total-N of Ultisols : In Table 4 shows that the effect of the dose of powder and NaOH *subbituminous* very significant to the content of soil organic C, but no significant effect on soil N. It is seen that the 20 ton / ha *subbituminous* powder and 10% NaOH is the best treatment to improve the content of soil organic C where an increase of 1.63% compared with the provision of 10 ton.ha^{-1}

of *Subbituminous*. While the treatment of 10 $ton.ha^{-1}$ of *Subbituminous* and 7.5% NaOH has been able to give a significant influence on soil organic C.

TABLE 4
EFFECT OF POWDER COAL *SUB-BITUMINOUS* AND NAOH TO ORGANIK C AND TOTAL N OF ULTISOLS

Sub-bituminous Powder + NaOH	Organic-C (%)	Total-N (%)
10 $ton.ha^{-1}$+ 0%	1.95 c	0.16
10 $ton.ha^{-1}$+ 2.5%	2.25 bc	0.17
10 $ton.ha^{-1}$+ 5%	2.40 bc	0.19
10 $ton.ha^{-1}$+ 7.5%	2.75 abc	0.19
10 $ton.ha^{-1}$+ 10%	3.01 abc	0.20
20 $ton.ha^{-1}$+ 0%	2.34 bc	0.17
20 $ton.ha^{-1}$+ 2.5%	3.16 ab	0.17
20 $ton.ha^{-1}$+ 5%	3.19 ab	0.17
20 $ton.ha^{-1}$+ 7.5%	3.21 ab	0.19
20 $ton.ha^{-1}$+ 10%	3.58 a	0.22
30 $ton.ha^{-1}$+ 0%	2.36 bc	0.17
30 $ton.ha^{-1}$+ 2.5%	2.68 abc	0.17
30 $ton.ha^{-1}$+ 5%	2.70 abc	0.19
30 $ton.ha^{-1}$+ 7.5%	2.73 abc	0.20
30 $ton.ha^{-1}$+ 10%	3.07 ab	0.21
CV	9.80%	7.46%

The numbers followed by the same lower case are not significant at the 5% level according to LSD

The provision of 20 $ton.ha^{-1}$ *subbituminous* and 10% of NaOH higher to produce Organic-C than other treatments because the powder *subbituminous* contains carbon elements have been decomposed during the incubation period. Based on [18] stated that the provision of *sub-bituminous* powder at doses of 0.5; 1,0; and 1.5 % (10, 20, and 30 $ton.ha^{-1}$) by the weight of soil which was activated by urea was increased the content of soil organic C. This increase is due to higher amounts of Urea ingredients, then the contribution to C-organic ingredients also high. Likewise with higher amounts of *sub-bituminous* Powder that has been activated with urea the more C-organic donations. This is because the *sub-bituminous* Powder contains organic-C > 30%. According to [19], coal comes from consolidated plants between other rock strata and is altered by a combination of heat and pressure effects over millions of years to form a coal seam. It makes the carbon content of coal high. Explained by [11] and [20] that humic acid is usually rich in carbon ranging between 41% and 57% and is capable of providing organic C that are readily absorbed by plants.

Giving of powder coal *Sub-bituminous* with NaOH have no significant effect on N-total in Ultisol. This is presumably because the incubation period is only 10 days resulted powder coal *Sub-bituminous* not perfect so the element N is owned by *sub-bituminous* still small. This is according to research conducted [21] that the powder coal *Sub-bituminous* treatment with 0.25 N NaOH mixing ingredients only able to increase 0.01% N-total soil on a 2 week incubation period and an increase of 0.02% total N soil compared powder coal *Sub-bituminous*.

According to [22] that application of organic matter affected significantly soil N and Organic-C. Increases in rates of organic matter application caused enhancement of soil chemical properties. Enhancement of chemical properties occured due to the content of organic material. Organic addition could cause organic carbon accumulation on the top soil [23].

3) Available P and CEC of Ultisols : Giving of powder coal *Sub-bituminous* with NaOH has not shown any significant effect on the content of available-P of Ultisols, but the real impact to CEC of Ultisols. It is suspected that the organic acid has not been effective in releasing fixation P in the soil. But seen from the figure has increased in line with increased doses of powder coal *Sub-bituminous* and NaOH compared powder coal *Sub-bituminous*.

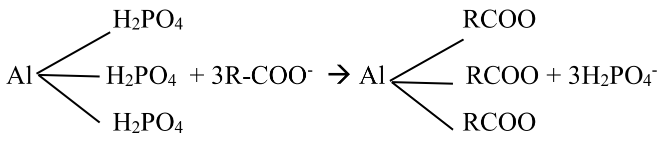
TABLE 5
EFFECT OF POWDER *SUB-BITUMINOUS* AND NAOH TO AVAILABLE-PAND CEC OF ULTISOLS

Sub-bituminous Powder + NaOH	Available P (ppm)	CEC ($me.100g^{-1}$)
10 $ton.ha^{-1}$+ 0%	7.83	19.76 f
10 $ton.ha^{-1}$+ 2.5%	8.18	34.04 bcdef
10 $ton.ha^{-1}$+ 5%	8.22	36.89 abcde
10 $ton.ha^{-1}$+ 7.5%	8.65	40.94 abc
10 $ton.ha^{-1}$+ 10%	10.02	48.79 a
20 $ton.ha^{-1}$+ 0%	9.03	24.51 ef
20 $ton.ha^{-1}$+ 2.5%	9.68	35.70 abcde
20 $ton.ha^{-1}$+ 5%	9.71	41.89 abc
20 $ton.ha^{-1}$+ 7.5%	9.82	44.03 abc
20 $ton.ha^{-1}$+ 10%	10.20	47.84 abc
30 $ton.ha^{-1}$+ 0%	8.06	25.94 def
30 $ton.ha^{-1}$+ 2.5%	9.17	33.80 cdef
30 $ton.ha^{-1}$+ 5%	9.41	34.98 abcde
30 $ton.ha^{-1}$+ 7.5%	9.74	39.51 abcd
30 $ton.ha^{-1}$+ 10%	11.73	48.32 ab
CV	0.13%	9.70%

The numbers followed by the same lower case are not significant at the 5% level according to LSD

Giving of *Sub-bituminous* powder with NaOH has not shown any significant effect on P-available Ultisol content. This is thought to be due to incomplete humic acid derived from *sub-bituminous* powder in binding Al^{3+} ions that fix P in the soil. However, judging by the number has increased along with increased doses of *Sub-bituminous* powder and NaOH compared with *Sub-bituminous* powders without NaOH.

According to [14] that P-available in acidic soil is fixed by Al and Fe ions. Al and Fe ions that fix the element P in the soil become difficult to dissolve so it can not be used by plants. therefore, given soil repair material to increase P available soil so as to increase soil fertility as in the following reaction:



While the provision of 30 ton.ha^{-1} *subbituminous* and 10% of NaOH was able to increase to CEC of Ultisols by 29.03 me.100g^{-1} compared with powder coal *Sub-bituminous*. Based on the stage I trial shows that the CEC of powder coal *Sub-bituminous* increasing the dose of powder coal *Sub-bituminous* and NaOH with the highest value of 148.20 me.100g^{-1}. The CEC of powder coal *Sub-bituminous* high CEC of Ultisols also increase as well. According to [24] humic acid derived from *Sub-bituminous* could be influence the value of CEC in the extreme. According to [25] proved that the treatment of *sub-bituminous* powder and 0.25 N NaOH in Ultisol could increase CEC by 15.27 me / 100 g.

4) SAR (Sodium Absorption Ratio) and ESP (Exchangeable Sodium Percentage) of Ultisols : Giving powder coal *Sub-bituminous* and NaOH a significant influence on the value of SAR and ESP, but no significant effect on EC Ultisols. Giving powder coal *Sub-bituminous* and NaOH fluctuating effect on the value of soil SAR. In the treatment of 10 and 30 ton.ha^{-1} of powder coal *Sub-bituminous* mixed with NaOH fluctuations in the value of SAR. It is seen that the use of powdered *subbituminous* as much as 10 and 20 ton / ha has a SAR value of 0.37 and 0.30 and impaired SAR when the powder coal *Sub-bituminous* is mixed with NaOH then increasing again. This is due to the use of powder coal *Sub-bituminous* capable of binding exchangeable Na ions in the soil thus reducing the SAR value compared to soil early. Similarly, the SAR value on providing *Sub-bituminous* powder and 2.5% of NaOH lower the SAR value because of increased CEC of powder coal *Sub-bituminous* suspected Na of soil can still be bound by powder coal *Sub-bituminous*. But along with the aexchition of NaOH, the SAR value increased again allegedly due to increased Na ions in the soil due to the aexchition of NaOH and complex powder coal *Sub-bituminous* already saturated by so many Natrium accumulated in the soil.

In the treatment of 20 ton.ha^{-1} of powder coal *Sub-bituminous* an increase in SAR values along with the aexchition of NaOH. This is thought to be due to the increased Na content when given NaOH and does not change the status of existing Mg and Ca ions. The soil SAR value after NaOH did not increase the SAR value is very high and is still normal so there is no dispersion on the soil.

Giving powder coal *Sub-bituminous* and NaOH treatment very significant effect on the value of ESP Ultisol. Ultisol ESP value decreases with the use of powdered *subbituminous* and NaOH. This is because NaOH will donate OH ions so that the pH increases powder coal *Sub-bituminous*. [24] stated that at a relatively high pH (concentration of H^+ is low) will increase the concentration of COO^- which can function as ligands on humic acid. The reason is what causes many Na ions are bound by powder coal *Sub-bituminous* functional groups such as COO^- so the exchangeable Na ions is reduced.

The SAR and ESP values of soil after treatment were still normal so that not to harm the soil and the plants. According to [26] soil belonging to sodic soils having SAR values of more than or equal to 13 and ESP values of more than or equal to 15.

TABLE 6
EFFECT OF POWDER COAL *SUB-BITUMINOUS* AND *NAOH TO* SAR, ESP AND EC OF ULTISOLS

Sub-bituminous Powder + NaOH	SAR	ESP (%)	EC (dS.m^{-1})
10 ton.ha^{-1}+ 0%	0.37 abcd	1.27 a	0.087
10 ton.ha^{-1}+ 2.5%	0.23 d	1.01 ab	0.081
10 ton.ha^{-1}+ 5%	0.31 abcd	0.81 bc	0.082
10 ton.ha^{-1}+ 7.5%	0.34 abcd	0.63 bc	0.084
10 ton.ha^{-1}+ 10%	0.40 abcd	0.60 bc	0.086
20 ton.ha^{-1}+ 0%	0.34 abcd	0.60 bc	0.094
20 ton.ha^{-1}+ 2.5%	0.37 abcd	0.57 c	0.074
20 ton.ha^{-1}+ 5%	0.42 abc	0.53 c	0.078
20 ton.ha^{-1}+ 7.5%	0.46 ab	0.51 c	0.085
20 ton.ha^{-1}+ 10%	0.48 a	0.51 c	0.087
30 ton.ha^{-1}+ 0%	0.30 bcd	0.50 c	0.088
30 ton.ha^{-1}+ 2.5%	0.27 cd	0.49 c	0.086
30 ton.ha^{-1}+ 5%	0.24 cd	0.48 c	0.089
30 ton.ha^{-1}+ 7.5%	0.29 bcd	0.47 c	0.090
30 ton.ha^{-1}+ 10%	0.34 abcd	0.45 c	0.091
CV	12.92%	15.64%	7.97%

The numbers followed by the same lower case are not significant at the 5% level according to LSD

Conductivity Electricity of soil after treatment gives different effects was not statistically significant. EC value for soil changed significantly due to the use of powdered NaOH and coal *Sub-bituminous* not increase of bases that do not increase the value of DHL. This can be attributed to the value of ESP that the presence of bases in soil does not change significantly.

EC soils exceeding 4 dS.m^{-1} or more are categorized as saline soils and EC values do not reach a value by 2.0 so it can be stated that the treated Ultisols were normal and does not affect the crop [26]

IV. CONCLUSION

The results of the stage I study a pH of 6.85 units and CEC amounted to 239.95 me / 100 g. Along with the increase in the provision of NaOH increased pH and CEC powder *subbituminous* so from that 0% to 10% NaOH been 0%, 2.5%, 5%. 7.5% and 10% for treating the soil in core research. Addition of NaOH in *Sub-bituminous* to increase the activity of powder coal *Sub-bituminous* with parameters increases the number of OH, C = O, and CH_3 groups.The results of stage II studies is the provision of a mixture of 20 ton (ha)$^{-1}$ powder coal *Sub-bituminous* and 10% of NaOH were able to increase the pH of H_2O, CEC, organic-C, Available-P, and Total-N Ultisol each of 1.49 units, 28.08 me.100g-1, 1.63 % C, 2.37 ppm P, 0.06% N, and decreases Al-exch Ultisol by 1.17 me.100g-1and , SAR Ultisol by 0.03, and ESP Ultisols by 0.82 % compared to nature soil.

ACKNOWLEDGEMENTS

We would like to thank to the Rector and Chairman of the Institute for Research and Community Service of Andalas University Padang, the Ministry of Research Technology and Higher Education Republic of Indonesia, the financial support of this research through research grants cluster professor of fiscal year 2016.

REFERENCES

[1] World Coal Association (WCA). 2016. Coal facts 2015, London, www.worldcoal.org, [5 April 2016].2016.

[2] Riley, J. T. Routine Coal and Coke Analysis: Collection, Interpretation, and Use of Analytical Data. ASTM International. USA. 104 hal.2007.

[3] Rezki, D. Ekstraksi bahan humat dari batubara (*Subbituminus*) dengan menggunakan 10 jenis pelarut.[skripsi]. Fakultas pertanian. Universitas Andalas. Padang. 63 hal. 2007.

[4] Herviyanti, T. B. Prasetyo, M. Harianti, A. Saidi. and Ismon L. Potency of humate material from *Sub-bituminous* and how to do Incubation with Fosfor-Fertilizer to Increase Upland Rice Production at Acidic Mineral Soil. *Greener Journal of Agricultural Sciences*. 2 (8) : 351-361. 2012.

[5] Hanafiah, K. A. *Dasar-Dasar Ilmu Tanah*. Rajawali Press. Jakarta. 359 hal. 2007.

[6] Sparks, D. L. *Environmental Soil Chemistry*.Edisi kedua.Academic Press: USA. P : 76-77. 2013.

[7] Tan, K.H. *Humic matter in soil chemistry. Principles and Controversies. Mercel dekker, Inc. New York.362 pp.* 2003.

[8] Fiorentino, G., R. Spaccini, and A. Piccolo. Separation of molekular constituens from a humic acid by solid-phase extraction following a transesterification reaction. *Talanta 68*, 1135-1142. 2006.

[9] Ghabbour EA, Davies G, Daggett Jr. JL, Worgul CA, Wyant A, Sayedbagheri M-M. Measuring the humic acid contents of commercial lignites and agricultural top soils in the National Soil Project. Annals of Environmental Science, 6: 1-12 Open access at www.aes.neu.edu. 2012.

[10] Tan, K. H. *Principles of Soil Chemistry*. CRC Press Taylor and Francis Group. 362 pp. 2010.

[11] Herviyanti, Azwar, dan Yusnaweti. Kajian Stabilitas Bubuk Tidak Produktif Dan Bahan Humatnya Yang Diekstrak Dengan Pupuk Buatan Untuk Meningkatkan Efisiensi Pemupukan Dan Produktifitas Ultisol Dan Oxisol. Laporan Hasil Kegiatan penelitian KKP3N .60 hal. 2014.

[12] Prasetyo, B. H. dan D. A. Suriadikarta. Karakteristik Potensi dan Teknologi Pengelolaan Tanah Ultisol Untuk Pengembangan Pertanian Lahan Kering di Indonesia. Balai Besar Penelitian dan Pengembangan Sumberdaya Lahan Pertanian dan Balai Penelitian Tanah. Bogor. *Jurnal Litbang Pertanian* 25 (2): 39 – 47. 2006.

[13] Hardjowigeno, S. *Ilmu Tanah*. Akademi Persindo. Jakarta. 268 hal. 2003.

[14] Painter, P.C.; M. Starsinic,.; M.M. Coleman. Determination of Functional Groups In Coal by Fourier Transform Interferometry. In Fourier Transform Infrared Spectroscopy; Ferraro, J.R., Basile, L.J., Eds.; Academic Press: New York, NY, USA; pp. 169–240. 1985.

[15] Chen, Y., C. Zou., M. Mastalerz., S. Hu., C. Gasaway., dan X. Tao. Applications of Micro-Fourier Transform Infrared Spectroscopy (FTIR) in the Geological Sciences—A Review.Int. J. Mol. Sci. 2015, 16, 30223–30250. MDPI, Basel, Switzerland. 2015.

[16] Yuliani, G., G.G.Grandistan., dan A.T. Mursito. Karakterisasi Adsorpsi Batubara Muda Termodifikasi Hidrogen Peroksida Menggunakan Metode Kontinyu Terhadap Metilen Biru. *Chimica et Natura Acta* Vol.3 No.1, April 2015:21-24. 2015.

[17] Brady, N.C. and R.R. Weil. The *Nature and Properties of Soils*. 13th ed. Pearson Education, Inc., New Jersey, USA. 2002.

[18] Herviyanti, T.B. Prasetyo, Juniarti, and D. Rezki. Activation Unproductive Coal Powder with Urea to Improve Chemical Properties of Ultisols. *International Journal on Advanced Science, Engineering and Information Technology*, Vol. 7 No. 3, pages: 957-963. 2017.

[19] World Coal Institute. (WCI). The Coal Resource: A Comprehensive Overview Of Coal. https://www.worldcoal.org/sites/default/files /coal_resource_overview_of_coal_report (03_06_2009).pdf. [5 April 2016]. 2005.

[20] Saito, B and Seckler, M.M. Alkaline Extraction of Humic Substances From Peat Applied To Organic-Mineral Fertilizer Production. *Brazilian Journal of Chemical Engineering*. Vol. 31, No. 03, pp. 675 – 682.2014.

[21] Shelly, N.W. *Pengujian Tingkat Keaktifan Campuran Bubuk subbituminousdengan Urea, KCl, NaOH dan NaCl Terhadap Beberapa Ciri Kimia Oxisol*.Skripsi Fakultas Pertanian. Universitas Andalas. Padang. 60 hal.2014.

[22] Junedi, H, Zurhalena, I. A. Mahbub. Short-Term Effect of China Violet Compost on Soil Properties of Ultisol and Peanut Yield. *International Journal on Advanced Science, Engineering and Information Technology*, Vol. 3 No. 31, pages: 50-53. 2013.

[23] Mantovi, P., G. Baldoni, and G. Toderi, Reuse of liquid, dewatered, and composted sewage sludge on agricultural land: effect on longterm application on soil and crop,"*Water Research*, vol. 39, pp. 289-296. 2005.

[24] Olivas, John. *Where Does Humic Acid Come From?*. Bioscientific. 2010.

[25] Amsar M. *Aktivasi Bubuk Subbituminus Dengan Urea, KCl, NaOH dan NaCl Untuk Memperbaiki Sifat Kimia Ultisol dan Meningkatkan Produksi Tanaman Jagung (Zea mays L.),* Skripsi Fakultas Pertanian Universitas Andalas. Padang. 82 hal. 2016.

[26] Ariyanto, D.P. *Artikel Ikatan Asam Organik Tanah dengan Logam*. Fakultas Pertanian Universitas Sebelas Maret Surakarta. http:// ariyanto.staff.uns.ac.id/files/2009/06/artikel-ikatan-asam-organik-dengan-logam.pdf.[1]September 2016]. 2016.