Study on the Capacity of Vermiculite of Adsorbing *Bacillus Polymyxa* to It

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The great leader Comrade **Kim Jong Il** said as follows.

"Scientists and technicians, basing themselves firmly on reality, must take the problems arising in practical socialist construction as the subjects of their scientific research, and solve the scientific and technological problems appearing in the application of the achievements of their work to production, in a responsible manner."

Bacillus polymyxa has been widely used in manufacturing the livestock feed additives and the organic compound fertilizer because of the ability to decompose apatite and silicates. [2]

The growth, multiplication and metabolism of microorganisms are closely connected with minerals. Therefore, the problem to use the natural mineral as carriers of microbes has been studied to a certain degree.[1, 2]

We cleared up the capacity of vermiculite of adsorbing ***Bacillus polymyxa*** to it and its reason.

Vermiculite samples from the Susan-ri, Kangso District, were calcinated at 700℃ and sieved in the size of 74 μm on average.

The powder of calcined vermiculite was placed on the plate of glass and liquid of ***Bacillus polymyxa*** was injected into the powder drop by drop. After 30 minutes, we observed the powder by the optical microscope(《Olympus optical chk 2 - FGS》 ×400). As a result, aggregation of microbic biomass on the surface of the vermiculite was shown.

We made the following experiment in order to estimate quantitatively the capacity of vermiculite of adsorbing ***Bacillus polymyxa*** to it.

First, we prepared 10 mL of water strained off coagulating bean curd as contrast plot and 10 mL of water strained off coagulating bean curd added 0.1g of powder of calcined vermiculite as test plot. Test materials were autoclaved at 112℃ for 30 minutes, and inoculated by the liquid of ***Bacillus polymyxa*** with 10^8unit/mL of original microbial content, and then cultivated in the thermostat for 24 hours. The mixtures were centrifuged and the supernatant liquid was chosen. We counted microbial content by using blood counting chamber under the monocular microscope (“LEICABF 200”×600). (Tab.1)

Tab.1 Proliferation of ***Bacillus polymyxa*** in water strained off coagulatingbean curd added the clacined vermiculite

culture medium	Microbial content/($\times 10^8$ unit mL^{-1})
water strained off coagulating bean curd	16.564
water strained off coagulating bean curd +vermiculite	1.359

As we can see in the Tab.1, microbial content in the water strained off coagulating bean curd added the calcined vermiculite was 1/12 of the water strained off coagulating bean curd. As a result, we can know that ***Bacillus polymyxa*** vigorous in the water strained off coagulating bean curd was adsorbed on the surface of vermiculite or vermiculite restraint the proliferation of ***Bacillus polymyxa***.

In order to make clear whether ***Bacillus polymyxa*** was adsorbed on the surface of vermiculite or vermiculite constrained the proliferation of ***Bacillus polymyxa***, thermo gravimetric (TG) analyses were carried out on TGA-5 from room temperature to 800℃.(Fig.1)

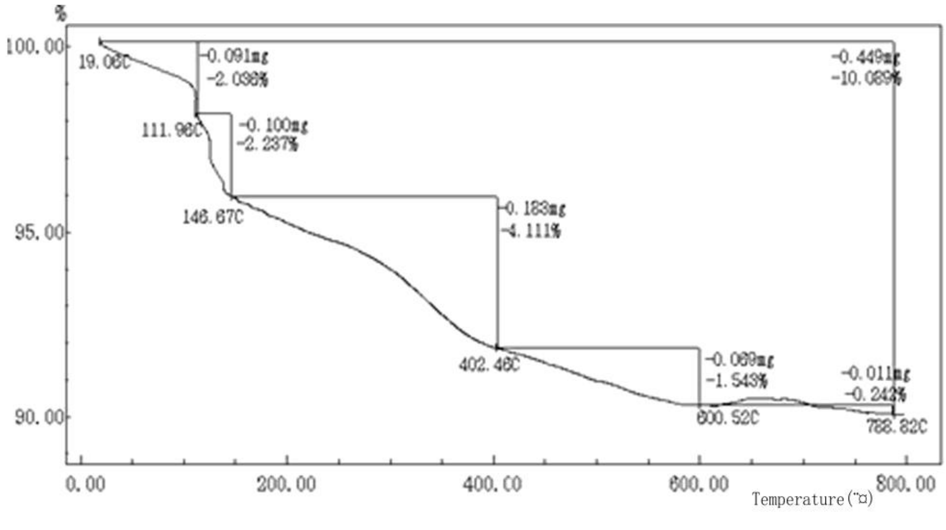

Fig.1. TGA curve of the vermiculite adsorbed ***Bacillus polymyxa***

In general, organic matter disintegrates at 300~500℃, but, in the curve of Fig.1, a new endothermic point not shown in the raw vermiculite was appeared at 402.46℃, at this time, mass loss was 4.111%. This is due to adsorption of ***Bacillus polymyxa*** on the surface of vermiculite, and corresponds with the result of microscope observation, that is, we can know vermiculite doesn’t constrain the proliferation of ***Bacillus polymyxa*** in the water strained off coagulating bean curd but adsorbs ***Bacillus polymyxa*** on its surface.

The first reason why ***Bacillus polymyxa*** is adsorbed on the surface of vermiculite is related to the characters of its crystal structure.

In the vermiculite crystal, cations in the structure units can be divided into 3 groups – cations in tetrahedron, cations in octahedron and cations in interlayer according to its situation, combination and migration ability.

Central cations in tetrahedron are Si^{4+}, Al^{3+} 6-coordination central cations in octahedron are Mg^{2+}, Fe^{2+}, Fe^{3+}, Al^{3+} and 6- or 8-coordination central cations in interlayer are Ca^{2+}, K^{+}, Na^{+}, Mg^{2+}.[3]

Combination strength of cations composed of structure unit in the vermiculite crystal is the greatest between central cations and ligands(O^{2-}) in tetrahedron and the next is between central cations and ligands (O^{2-}, OH^{-}) in the octahedron, between cations and ligands (O^{2-}, OH^{-}) in the interlayer is the smallest. Because the combination length between the central cations of tetrahedron and ligands is short and symmetry of coordination polyhedron is low, and cations in the interlayer were surrounded with thin membrane of hydrates to form the weak electrostatic combination with ligands.

Because of the characteristics of crystal structure, vermiculite easily separated into the unit structures of T-O-T to expand when heated. When expanded, vermiculite’s specific surface increases to absorb ***Bacillus polymyxa*** fully.

The second reason why ***Bacillus polymyxa*** is adsorbed on the surface of vermiculite is that vermiculite includes many elements necessary for microbe proliferation. For example, because the radius of Fe^{3+} formed by oxidation of Fe^{2+} is small, it passes easily through cell membrane and control the osmotic pressure.

In addition, vermiculite includes Mn^{2+}, Cu^{2+}, Co^{2+}, Zn^{2+} and B^{3+} affected to the synthesis and the activity of various kinds of ferments.(Tab.2)

Tab.2. Movable nutrient components in vermiculite

nutrient components	content/(mg $\cdot 10^{-2}g^{-1}$)	nutrient components	content/(mg $\cdot 10^{-2}g^{-1}$)
P_2O_5	25.3	Mn	88.1
K_2O	12.6	Co	0.182
SiO_2	75.8	Zn	22.7
MgO	0.514	Cu	0.41
Fe_2O_3	0.036	B	0.01

Vermiculite also fixes Al^{3+} bad for growth of microbe in the tetrahedron units to cover and acts as heat insulator necessary for growth of microbe due to the very low thermal conductivity.($\lambda = 0.17 \sim 0.21 kJ/(mol \cdot h)$)

Conclusion

Expanded vermiculite can be a good microbe carrier because of its large surface area, many nutrition elements and low thermal conductivity.

References

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