2024年臺灣國際科學展覽會
優勝作品專輯

作品編號　050022

參展科別　動物學

作品名稱　Straw manufacturing for epidemic prevention

得獎獎項　三等獎

就讀學校　Heamil-HighSchool
Heungdeok Highschool

指導教師　Jang Jaehee

作者姓名　Kwak KoEun、Roh Sua

作者照片

Manufacturing of Straw Bedding for the Prevention of Infectious Diseases

Heamil-HighSchool 2grade-Kwak KoEun , Heungdeok HighSchool 1grade-ROH Sua

1. abstract

Recently, the feed prices for livestock farms have been continuously increasing, while the prices of calves have been declining, leading to many livestock and dairy farms facing financial losses. If livestock farms are affected by diseases such as foot-and-mouth disease, they suffer significant losses. This is because reduced productivity in livestock not only affects their production but also entails substantial costs for vaccines and treatments. Therefore, there is a need to explore how to effectively prevent diseases, focusing on common diseases in cattle such as subclinical mastitis and mastitis, and alleviate the burden on farms economically and environmentally. This study aims to investigate the production of bacterial growth-inhibiting straw bedding using substances such as illite and charcoal to contribute to disease prevention.

2. Overview of the Study

2. Theoretical Background
A. Straw Bedding

1) Definition of Straw Bedding
Straw bedding refers to straw or sawdust spread on the floor of animal shelters. It is recommended to keep the straw dry, and a thickness of 5-10cm is typical.

2) Functions of Straw Bedding
Straw bedding has a significant impact on creating a comfortable living environment for livestock to rest and grow. It is closely related to health, hoof condition, and the overall lifespan of the skin. Two factors that affect the condition of straw bedding are division and moisture. If the moisture content of straw bedding is excessively high, the bacterial count increases, leading to a higher incidence of subclinical mastitis and mastitis.
a) Function of Moisture Control

When raising cattle on concrete floors without straw bedding, the high moisture content of manure causes the floor to become sticky, leaving inadequate space for cattle to rest. The higher the moisture absorption rate of straw bedding, the wider the resting space for cattle, reducing the risk of slipping and injuries.

b) Function of Odor and Pest Control

Manure generates odor due to ammonia nitrogen derived from nitrogen compounds and volatile organic acids produced during the fermentation process. It also becomes a breeding ground for pests. Straw bedding assists in the fermentation of manure and reduces the occurrence of odor through its absorbent properties.

B. Major Diseases in Cattle

1) Mastitis

Mastitis is a disease defined as an infection within the mammary gland. It causes significant economic losses in the global dairy industry due to decreased milk production and costs associated with treatment, culling, and death. Mastitis can infiltrate the mammary tissue through the surrounding environment, such as soil, feces, reproductive organ secretions, contaminated straw bedding, teats, and udders, and is often caused by environmental pathogens such as Escherichia coli. It is causing serious economic damage by inducing mastitis in cows.

2) Subclinical Mastitis

Subclinical mastitis, also known as digital dermatitis, refers to a disease characterized by suppurative and necrotic skin inflammation between the claws of cattle. It is recognized as one of the three major diseases on dairy farms, along with reproductive disorders and mastitis. Once it occurs, it continues to be a problem and causes significant economic losses. Subclinical mastitis is a seasonal disease that occurs frequently during extremely humid summer and winter seasons, as well as during droughts.

C. Investigated Substances for Bacterial inhibition

1) Illite

a) Definition of Illite

Illite is a type of clay mineral generated through the hydrothermal alteration of marine sedimentary rocks formed approximately 500 million years ago. It emits infrared radiation and generates a large amount of negative ions. Illite has the effect of adsorption, purification, and detoxification, as well as preventing the habitat and reproduction of harmful bacteria and mold in the human body. It has been confirmed that a significant amount of illite is deposited in the central-northern region of the East. It is being utilized in the field of agriculture.

b) Characteristics of Illite

(1) Antibacterial Action

It contains components that exhibit antibacterial effects against viruses, bacteria, and mold, thereby preventing food poisoning when the ingredient is added to the feed of livestock.
(2) Adsorption Action
It can adsorb, remove, and decompose various heavy metals and toxic gases from water, soil, and the atmosphere, contributing to the prevention of environmental pollution.

2) Charcoal
a) Charcoal
Also known as "moktan," it is typically made from hard, dense wood materials. In Korea, hardwood species, such as oak, are primarily used. Charcoal made from oak is called "chamsoot." It is categorized into lower-quality "geomtan" and higher-quality "baektan." There are also powdered charcoal and charcoal fines. When producing charcoal, wood gas, wood vinegar, and wood tar are generated.

b) Characteristics of Charcoal

(1) Absorbs Moisture
Charcoal, which is a porous carbon material, can absorb moisture and help regulate humidity.
(2) Purification function
When charcoal is heated at high temperatures, it becomes alkaline with a pH of 8-9. This alkaline nature can be used to neutralize acidity in soil or transform acidic water into alkaline water when added to beverages. Charcoal can also help purify tap water by breaking down harmful substances like chlorine.
3) Slippery elm
a) Definition of slippery elm
Slippery elm is the bark of the paulownia tree. The paulownia tree grows to a height of about 15m with a diameter of around 1m. Its leaves are oval-shaped. The bark of the tree is dark greyish-black and fragmented, while young branches are white with a greyish hue and hang down.

b) Benefits of slippery elm
Slippery elm has long been used as a traditional remedy for various inflammatory conditions such as arthritis, joint inflammation, gastric ulcers, and pleurisy. Compounds derived from slippery elm have antioxidant properties and can help reduce free radicals. It also has immunomodulatory effects, and extracts from slippery elm have shown the potential to inhibit the spread of cancer cells. It is a valuable natural resource with promising health benefits that can be extracted and utilized for various purposes.

3. Exploration Process and Results

Exploration 1: Measurement of Moisture Absorption Rate for Each Substance

Straw plays a significant role in preventing slipperiness and creating a hygienic barn environment through moisture absorption. Therefore, to determine if the mixture materials fulfill the basic role of straw and assess their impact on bacterial growth through moisture absorption, the moisture absorption rates of each substance are measured.

Moisture Absorption Capability of Tested Mixture Materials

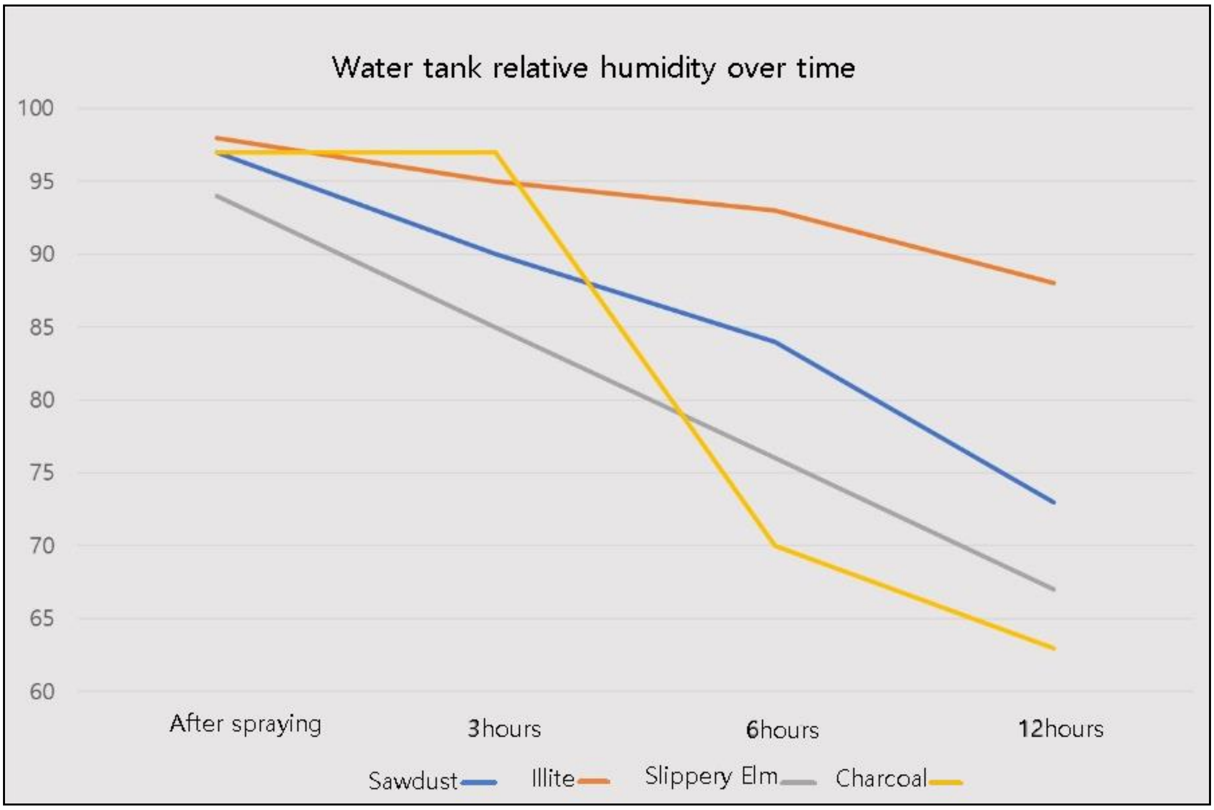
A. Preparation Materials
Illite, charcoal, straw, slippery elm(powdered), humidity measurement device, 4 acrylic tanks, plastic wrap

B. Experimental Procedure
1) Place 300g of illite, charcoal, straw, and slippery elm(powdered) in separate tanks.
2) Fix the humidity measurement device inside each tank, ensuring that the sensors do not touch the mixture materials.
3) Spray a certain amount of moisture into the tanks using a sprayer, then seal them with plastic wrap.

4) Use the humidity measurement device to measure the relative humidity changes in the tanks at different time intervals over a period of 12 hours.

	
Measurement of Moisture Absorption Rate for sawdust	Measurement of Moisture Absorption Rate for Charcoal
	
Measurement of Moisture Absorption Rate for sawdust	Measurement of Moisture Absorption Rate for Charcoal

Experimental Results



분사직후: After spraying

Sawdust, Illite, and Charcoal all showed moisture absorption capabilities. As evident from the graph, it was observed through the experiment that the moisture absorption abilities were superior in the following order: Charcoal, Rhubarb Root Bark, Sawdust, and Illite. This confirmed the previous research that predicted Illite to have lower moisture absorption rate compared to sawdust or charcoal due to its lower porosity as a clay minerai. By finding the optimal ratio of these four materials with moisture absorption rates, it is expected to create conditions that hinder bacterial growth by absorbing moisture in the surrounding straw bedding.

Exploration 2: Determination of Mixing Ratios of Composite Materials based on Antibacterial Ability

In order to determine the most effective mixing ratio in terms of antibacterial ability, various combinations of sawdust, illite, rhubarb root bark, and charcoal will be mixed to create composite materials. These composite materials will then be inoculated with Escherichia coli (E. coli) to assess their growth levels. The aim is to determine the mixing ratio that exhibits the strongest antibacterial ability.

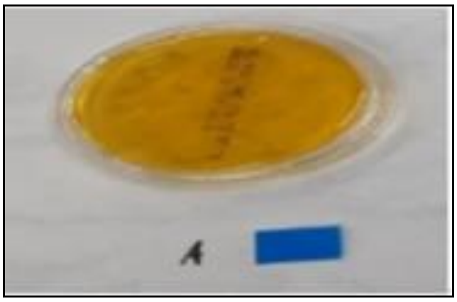
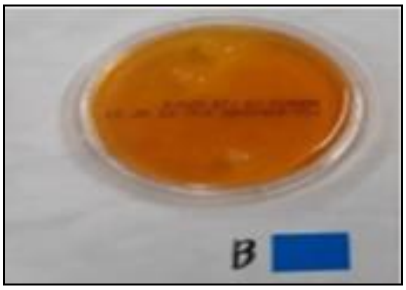
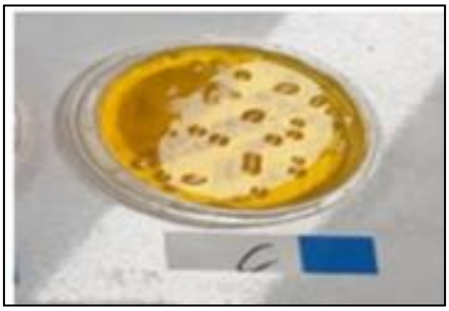
Determination of Mixing Ratios for the Experimental Composite Materials.
Category

categ orize	Sawdust	Illite	Slippery Elm (powered)	Charcoal
A	200g	40g	40g	20g
B	200g	30g	30g	40g
C	200g	45g	45g	10g
D	200g	35g	35g	30g

Measurement of Antibacterial Ability according to Mixing Ratios

A. Materials
Four containers containing different mixing ratios of A, B, C, and D, LB agar (solid medium), spreader, micropipette, sterilized distilled water, Escherichia coli (E. coli), paraffin film.

B. Experimental Procedure
1) Use an electronic balance to accurately measure and mix the respective blending materials (sawdust, vermiculite, charcoal, yeast extract) in the four containers according to the designated ratios.
2) Inoculate 50ml of E. coli in the central area of each container.
3) Leave the containers at room temperature for approximately 9 hours after inoculation.
4) After sufficient time has passed, collect 5g of the sawdust mixture from the inoculation site of the bacteria and dilute it 1000 times in sterilized distilled water.
5) Filter the diluted solution multiple times to remove impurities, then spread 1ml of the suspension on the solid medium using a spreader and cover the medium with the lid.
6) Compare the growth of colonies after incubating for over 24 hours at 35 degrees Celsius in an incubator.

	
A. Sawdust 200g, Illite 40g, Slippery elm 40g, Charcoal 20g	B. Sawdust 200g, Illite 30g, Slippery elm 30g, Charcoal 40g
	
C. Sawdust 200g, Illite 45g, Slippery elm 45g, Charcoal 10g	D. Sawdust 200g, Illite 35g, Slippery elm 35g, Charcoal 30g

Colonies were formed in agar A, B, and C, but in D, no colonies were formed and it exhibited a transparent reddish color similar to before the application. Considering this as an experimental error, it was decided to conduct a repeat experiment. Based on the current results of the agar experiments, a higher ratio of vermiculite and yeast extract in the sawdust showed better antibacterial ability. Charcoal showed excellent moisture absorption but had little impact on antibacterial properties. Additional experiments are underway to further clarify the experimental results.

5. Conclusion

1. Exploration 1: Comparison of moisture absorption rates for each substance - It was confirmed that vermiculite, sawdust, charcoal, and yeast extract all have moisture absorption capabilities.

- Among them, charcoal and yeast extract exhibited superior moisture absorption, while vermiculite showed lower moisture absorption compared to other substances.
- Vermiculite, as a clay mineral, has less porosity compared to other substances, resulting in lower moisture absorption. However, it is already proven to have excellent antibacterial effects. Therefore, it is believed to be effective when mixed with sawdust, charcoal, yeast extract, etc.

2. Exploration 2: Determining the mixing ratios of blending materials based on antibacterial ability

- It was confirmed that there was antibacterial activity in all mixing ratios based on the experiment conducted with Escherichia coli, which can be a major cause of mastitis.
- After collecting and diluting the solution from the E. coli injected into each container, colonies were observed in all four containers except for one.
- Considering it as an experimental error, repeat experiments are in progress. Sufficient confirmation of the antibacterial effects of the mixture of yeast extract, vermiculite, and charcoal on Escherichia coli has been obtained, and meaningful results are expected to be derived.

6. Utilization and Prospects

1. The produced straw with antibacterial proliferation inhibition capabilities can suppress bacterial growth compared to conventional straw, thus inhibiting the spread and infection of
pathogens through straw. This is expected to lead to the prevention of economic losses in agricultural households and deliver a positive impact on livestock farms.
2. The included vermiculite in the produced straw has the ability to adsorb harmful gases and toxins from pesticides, as well as prevent diseases and pests. The yeast extract is effective in inhibiting and preventing cancer cells. Therefore, the produced straw can contribute positively to the environmental conditions in livestock facilities compared to conventional straw. By utilizing the yeast extract, which has traditionally been used in Korean herbal medicine, and

vermiculite from Yeongdong County, which has a mining industry, it is possible to nurture an industry that can gain competitiveness in exports and expect positive growth prospects in the related industry.

7. References and Websites

References

References:

Choi, I. H., Lee, S. J., & Kim, C. M. (2007). Study on the Effects of Various Additives on the Ph and Solubility of Straw in a Short Period. [Korean Society of Environmental Science Cho, H. S., Lee, S. H., Lee, J. H., & Ahn, H. K. (2015). Evaluation of Dairy Cattle Manure Production
in Bedded Pack Barns. [Korean Society of Livestock and Environmental Facilities! Lee, E. S. (2005). Resistance to Antibiotics and Serogenetic Characteristics of Gram-Negative Bacteria Isolated from Mastitis in Dairy Cows. I'Master's thesis, Konkuk University Kim, S. G. (2013). A Study on the Optimal Stocking Density and Bedding Thickness for Environmentally Friendly Hanwoo Cattle Production. Master's thesis, Kangwon National University
In, M. J., & Kim, D. C. (2016). Antioxidant and Antiproliferative Activities of Acetone Extracts

Website
National Assembly Library http://nanet.go.kr

【評語】050022

This research attempts to solve the problem of livestock disease by using straw bedding to reduce the moisture and increase antibacterial ability. The result is promising and some of the causing factors were measured and confirmed.

Suggestion:

1. The experiment for determination of mixing ratios should be designed carefully, and the data should be analyzed statistically.
2. The data should be repeated at least three times and further analyze using statistical approach.
3. Besides anti-bacteria and reducing humidity, other factors also need to take consideration, such as deodorization, comfortability and cost.
4. Commercial products which have been used in animal farms should be used as a control.