Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
May-June 2022 Page No. 363-376
Article History: Received: 24 February 2022, Revised: 05 April 2022, Accepted: 08 May 2022, Publication: 30 June 2022

Study of Seedling Trays for Raising Seedlings with Cow Dung Biomass

Bo Zhang[1], Wei Zhang[2*], Yongcai Ma[2]

[1]School of Information and Electrical Engineering, Heilongjiang Bayi Agricultural University, Daqing, Heilongjiang, China

[2]School of Engineering, Heilongjiang Bayi Agricultural University, Daqing, Heilongjiang, China

*Corresponding Author.

Abstract:

In this study, using the glass transition characteristics of lignin and cow dung as raw materials, a method for preparing a biomass seedling tray for corn transplanting without adhesive added was studied. The corn seedling tray is prepared by the method of heating and compression molding. The forming mechanism of the biomass seedling tray was revealed through the biomass seedling tray forming test combined with the electron microscope analysis. The stalk fibers in the cow dung are compressed together to form a laminated mosaic structure. The mechanical mosaic force generated by the stacking of the stalk fibers is the main strength of the seedling tray. Source: The temperature of the mold increases to make the lignin in the material reach the softening temperature. After the lignin is precipitated under the action of internal stress, it adheres to the adjacent stalk fibers to form a new whole. There are more adjacent stalk fibers, and at the same time, a lignin layer is formed outside the fiber laminated mosaic structure in the cow dung; when the material temperature is lower than the glass transition temperature of the lignin, the seedling tray is formed. Therefore, under the premise that the material can be completely filled in the mold, the lower the moisture content, the better the strength and water resistance of the porous seedling pot after molding. This study provides a new method for the functional utilization of agricultural waste.

Keywords*: Biomass, Lignin, Molding, Seedling Transplanting, Seedling Pot.*

I. INTRODUCTION

In recent years, the development of animal husbandry is on the rise, and the scale of breeding shows a trend of increasing year by year, but the pollution caused by livestock manure restricts the sustainable development of animal husbandry. According to statistics, the daily defecation volume of each cow is 5-6% of its body weight, and the daily feces excretion volume of a 450kg cow will be as high as 25kg. Based on this calculation, the volume of manure discharged by each cow in a year will be as high as 9000kg [1], with the continuous improvement of the environmental protection concept of animal husbandry, breeders are also more active in seeking harmless disposal methods of manure, so as to realize the sustainable development of the dairy farming industry.

Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
May-June 2022 Page No. 363-376
Article History: Received: 24 February 2022, Revised: 05 April 2022, Accepted: 08 May 2022, Publication: 30 June 2022

Heilongjiang has a vast territory and is the main corn producing area in China. The traditional corn planting method is field sowing. Due to Heilongjiang's high latitude geographical location, cold climate and short frost-free period, these geographical disadvantages lead to a short corn planting cycle in Heilongjiang[2]. Therefore, corn with traditional planting methods has poor quality and low yield. In order to prolong the growth period of corn, the corn seedling transplanting technology can effectively increase the growth period of corn. Using this technology for corn planting can extend the growth period of corn by about half a month, so as to alleviate the problems of low temperature and short planting period in Heilongjiang, and improve corn yield. The effective way is to first sow the corn seeds in the porous seedling pots in the seedling-raising greenhouse, wait for the corn to emerge and then transplant to the field [3]. Common seedling trays include plastic-based nursery trays, paper-based nursery trays, animal manure-based nutritional bowls, and clay and straw-based nursery trays. At present, it seems that plastic seedling trays are mostly used when raising seedlings in China, but their air permeability is poor, and plastics cannot be degraded in the soil. Long-term use will cause environmental pollution, and it is easy to damage the roots of seedlings when transplanting, which will affect the seedlings. survival rate[4]. Relatively speaking, the air permeability of paper seedling trays is better, and the air permeability is also better than that of plastic seedling trays, but its production cost is relatively high, and paper seedling trays are not suitable for use in high-humidity environments[5]. The nutrition bowl is a seedling tray in the form of a single bowl, so the nutrition bowl is not suitable for transplanting and automatic transplanting in large-scale planting. Production, promotion and application are difficult. The porous seedling pot made of degradable materials does not need to take out the pot seedlings when transplanting, and the porous seedling pot can be directly moved into the field together with the pot seedlings, which not only simplifies the transplanting process but also does not cause pollution to the environment[6].

Cow dung contains a large amount of lignin and cellulose. Using cow dung to prepare degradable seedling trays can simplify the mechanical structure of supporting transplanting, promote the popularization and application of seedling raising and transplanting technology, and provide solutions for the functional utilization of cow dung. . At present, cow dung is mainly used for feed, energy and fertilizer [7-9]. As feed, cow dung is mainly obtained by mechanical drying method, but it is easy to lose some nutrients, and it has large one-time investment, large energy consumption, and easy to cause secondary environmental pollution; although biological fermented cow dung feed has no peculiar smell[10], good palatability, and digestion However, due to the large amount of additives used in the production of livestock and poultry, most of them remain in the feces, and when the feces are used as feed, the problem of excessive or even poisoning may occur [11]. The energy conversion of cow manure is mainly anaerobic fermentation to produce biogas. At present, how to improve the output rate of biogas is the key problem restricting its development. At the same time, the cost of biogas projects is generally relatively high, the investment is large, and the operation effect is greatly affected by temperature and season. Its promotion in some areas, especially in the northern regions with colder winters, is limited [12]. Cow dung is a traditional method commonly used in countries around the world as fertilizers. This utilization method can not only effectively utilize the organic matter, nitrogen, phosphorus and some trace elements in cow dung, but also has the characteristics of low cost and large amount of treatment, but from an economic point of view, the added value of fertilizer utilization products is relatively low . In the research of expanding the

Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
May-June 2022 Page No. 363-376
Article History: Received: 24 February 2022, Revised: 05 April 2022, Accepted: 08 May 2022, Publication: 30 June 2022

application of cow dung in new fields, our team has proposed and tried that if we can successfully prepare degradable seedling trays based on cow dung, it is possible to increase the economic added value of cow dung utilization. Satisfy and simplify the corn mechanized seedling raising and transplanting process, and promote the popularization and application of corn seedling raising and transplanting technology[13].

However, a large number of previous research results by my team and I have shown that cow dung in the conventional state has poor adhesion and hydrophilicity. Therefore, the use of cow dung to prepare degradable porous seedling pots needs to be solved. It is how to make the cow dung bond and form without adding additional binder, and the porous seedling pot after forming can meet the transplanting strength requirements after the seedlings are raised[14]. At present, the research on the preparation of degradable porous seedling pots and related mechanisms in agricultural production mainly focuses on the mixing and molding of degradable substances and binders[15]. The inside of the water-resistant paper is mixed with a layer of plastic water-resistant thin layer, which is not conducive to the degradation of the porous seedling pot. Therefore, this method is not conducive to environmental protection. Some scholars use the same principle to use starch glue and pulverized crop straw as raw materials, fully mix the two and then heat and form a porous seedling pot. However, in the production process, the pulverized crop straw needs to be added in a mass ratio of about 10%. Only the starch glue can meet the strength requirements of the porous seedling pot, and the price of starch glue is relatively high, so this method is not economical[16].

Therefore, this study utilizes the glass transition characteristics of lignin in cow dung. By pressurizing cow dung and trying to heat the lignin to reach the glass transition temperature, the molecular chain will move, soften and become viscous to produce viscose force. Forming mechanism of degradable porous seedling pots prepared from cow dung autologous lignin. Scanning electron microscope (SEM) was used to verify the reorganization of its physical structure from a microscopic point of view. The research results provided a theoretical basis for the formation of biomass porous seedling pots, and provided a new approach and new solution for the functional utilization of cow dung.

II. MATERIALS AND METHODS

2.1 Materials

The cow dung raw materials used in the test were all taken from Beingmate's industrialized dairy cattle breeding base in Anda City, Heilongjiang Province, China. Lignin, cellulose and hemicellulose were determined by isoconcentration sulfuric acid method and 72% concentrated sulfuric acid hydrolysis method respectively. See TABLE I (Chaves et al. 2002; Linetal. 2012).

Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
May-June 2022 Page No. 363-376
Article History: Received: 24 February 2022, Revised: 05 April 2022, Accepted: 08 May 2022, Publication: 30 June 2022

TABLE I. Dry matter composition of cow dung raw materials.

INDEX	CONTENT(%)
Lignin	23.4
Cellulose	21.3
Hemicellulose	13.7

2.2 Cow dung raw material pretreatment

Take 4 cow dung samples and place them in a dark and ventilated environment to dry in the shade to reduce the moisture content, until the moisture content (MC) in the 4 cow dung samples drops to 15%, 18%, 21% and 24%, respectively. MC1, MC2, MC3 and MC4 were used to represent four kinds of cow dung samples with different moisture content, respectively. Put the cow dung raw material after drying in the shade into a counter-rotating low-speed mixer (Bingcheng BH-12.5, Harbin, China), set the operating speed of the mixer to 20 r/min, and continuously stir the cow dung raw material for 10 min. After stirring, the cow dung appears In the loose state, the average looseness is 0.43t/m^3 (Fig 1).

Fig 1: Treated cow dung

2.3 Normal temperature compression molding experiment

2.3.1 Method

Take 250g of the processed cow dung raw material and put it into a compression molding mold. The mold was designed and developed by my team and is specially used for the molding research of corn porous seedling pots (Fig. 2). The filling of the cow dung raw material into the corn porous seedling pot molding die was compressed by a press (YJ-1000, Xiangyangmachineryfactory.Zhejiang, China), and the operating parameter of the press was set to 20MPa. After the mold is fully compressed, the pressure is maintained, the pressure holding time is 20s, and the mold is demolded after the pressure holding process. The porous seedling pots obtained after demoulding were placed at room temperature to dry for 48 hours. The designed production size of the corn porous seedling pot mold is 276.5mm×42mm×35mm (length×width×height). The specific structure and overall size of the corn porous seedling pot are shown in Fig 3.

Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
May-June 2022 Page No. 363-376
Article History: Received: 24 February 2022, Revised: 05 April 2022, Accepted: 08 May 2022, Publication: 30 June 2022

Fig 2: Corn Porous Seedling Bowl Compression Molding Mould

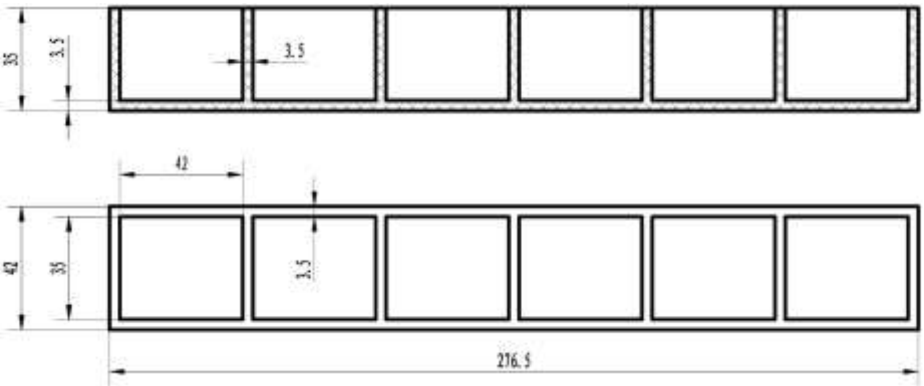

Fig 3: The specific structure and overall size of the corn porous seedling pot

2.3.2 Experiment results and discussion of room temperature compression molding

Fig. 4 shows the shape of the room temperature compression molding porous seedling pots made of cow dung raw materials (MC1, MC2, MC3, MC4) with different moisture contents after drying at room temperature. It can be seen from the top view of the MC1 cold-pressed porous seedling pot (Fig. A1) that the outer wall and the upper edge of the hole dividing wall are loose. The side view (Fig. A2) shows that the outer wall of the porous seedling pot is incomplete, and the bottom of the porous seedling pot (thickness 8.3± 1.2mm) material accumulation is serious and the side is multi-layer fracture. At the beginning of the formation of the porous seedling pot, the material is compressed, the porosity is reduced, and it accumulates at the bottom of the mold frame. When the pressure applied to the mold continues to increase, the pressure inside the mold also continues to rise, and the material accumulated at the bottom of the mold will be compressed and will generate a component force that expands outward along the bottom of the mold. When the component force is greater than the flow stress of the material itself When the material flows and begins to fill from the bottom to the inner wall of the mold material frame and the cavity of the porous seedling pot, the side wall of the porous seedling pot is formed. The difference of MC in the raw material will affect the molding integrity of the porous seedling pot, and also affect the fluidity of the material in the mold (Tumuluru J.S. 2018). The flow stress of the material increases in a gradient

Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
May-June 2022 Page No. 363-376
Article History: Received: 24 February 2022, Revised: 05 April 2022, Accepted: 08 May 2022, Publication: 30 June 2022

with the decrease of MC. After the MC1 material is compressed and formed at the bottom of the porous seedling pot, the high flow stress of the material is difficult to fill the side wall of the material frame after the bottom is accumulated, and the side wall of the porous seedling pot cannot be formed. And the bottom of the thicker porous seedling pot causes density stratification due to pressure conduction attenuation, thus resulting in multi-layer fracture. In the top and side views of the MC2 material cold-pressed porous seedling pot (Fig. 4 B1B2), the side wall of the porous seedling pot is not broken, the bottom thickness of the porous seedling pot is 7.3±0.3mm, and the upper edge has a depth of 5.6±2.1mm and the part is not fully formed. After the pressurization, the material is filled from the bottom to the side wall of the material frame, and the upward flowing material contacts the lower surface of the male mold and continues to accumulate to generate pressure to form the top of the porous seedling pot. The increase in the material flow distance leads to an increase in the contact area between the material and the inner wall of the material frame, which in turn increases the flow resistance. The material flowability of MC2 is poor, so the material in the upper half of the side wall cannot flow to the state where it can contact the lower surface of the male mold, so the compression molding cannot be completed; MC3 and MC4 materials are completely formed after room temperature compression, and the bottom thickness of the porous seedling pot is 4.6±0.2mm and 5.1±0.2mm, respectively. It can be seen from Figure 5C1 that the upper edge of the MC3 porous seedling pot is relatively neat, and the outer surface is flat (Fig. 4 C2). It can be seen from Fig. 4 D1 that the outer surface of the MC4 porous seedling pot is uneven and there is overflow material on the upper edge of the porous seedling pot. The forming mold is a semi-closed mold. There is a 0.2mm gap between the upper surface of the material frame and the lower surface of the male mold. During the compression process, the material flows upward along the inner surface of the material frame and contacts the lower surface of the male mold. After the pressure in the mold cavity increases, compared with the MC4 material The MC3 material has better fluidity, and the required internal and external pressure difference is smaller when passing through the pores of the same size (Street et al. 1996). Therefore, after the material MC4 is cold-pressed, there is overflow material on the upper edge of the porous seedling pot. The premise of meeting the requirements for raising seedlings is the integrity of the porous seedling pot. In the above room temperature compression molding test results, the porous seedling pot can be completely formed when the moisture content of the material is 21% and 24%. Therefore, MC3 and MC4 materials were selected for the hot-press forming test.

Fig 4: Normal temperature compression molding porous seedling pot

2.4 Molding Experiment of Heating Compressed Biomass Porous Seedling Tray

2.4.1 Method

Before the test, the molding mold of the corn porous seedling pot should be transformed to have the function of heating the internal materials. Therefore, the electromagnetic heating coil of the electromagnetic induction heater needs to be wound on the outer surface of the mold material frame (5-220,

Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
May-June 2022 Page No. 363-376
Article History: Received: 24 February 2022, Revised: 05 April 2022, Accepted: 08 May 2022, Publication: 30 June 2022

Haojiarun Electric Co., Ltd.Guangdong, China). After the installation of the electromagnetic heating coil is completed, the current in the electromagnetic heating coil is adjusted and increased by the controller of the electromagnetic induction heater, so that the outer frame of the mold is continuously heated under the action of electromagnetic induction. Adjust the current value of the electromagnetic heating coil to keep the mold temperature constant at 230° C. Take 250g of the processed cow dung raw material (MC of the complete molding material in the room temperature compression molding test), put it into the corn porous seedling pot and put it into the compression molding mold, set the operating parameters of the press to 20MPa, compress the mold, and keep the pressure and keep warm for 20s after the compression is completed. Wait for the mold temperature to naturally drop below 50° C for drafting.

2.4.2 Experimental Results and Discussion of Heating Compression Molding

The shape of the hot-pressed porous seedling pot after drying at room temperature is shown in Fig. 5. Fig. 5E shows the porous seedling pot prepared with material MC3. It can be seen from E1 and E2 that the upper edge of the porous seedling pot is neat and the outer wall is smooth. Fig. 5F shows the porous seedling pot prepared by using the material MC4. Although the outer wall is smooth, there is material overflow on the upper edge of the porous seedling pot. This phenomenon is also caused by the better fluidity of the material.

Fig 5: Heating compression molding porous seedling pot

2.5 Seedling experiment

2-3 days before sowing, first soak corn seeds (Kenfeng No. 1), soaking water temperature 30-35 ℃, soaking time 12h, soaked seeds need to filter out excess water before use. Put the soaked seeds in the seed Cui Yaxiang for germination. The temperature of the germination box is set to 32° C, and the germination time is 36 hours. During the germination process, the seeds are turned every 8 hours, and the radicle will be exposed after the germination is completed. Take the room-temperature compression-molded porous seedling pots and the hot-pressed porous seedling pots, respectively, lay 2 cm of subsoil in the holes, sow a seed after germination into each hole, and cover the surface with a layer of topsoil until it is close to the edge of the hole of the porous seedling pot. level, then water the porous seedling pots until the seedling soil is completely wet. The temperature of the nursery environment is 25±2℃, the environmental humidity is 45-65%, and the nursery time is 15d.

Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
May-June 2022 Page No. 363-376
Article History: Received: 24 February 2022, Revised: 05 April 2022, Accepted: 08 May 2022, Publication: 30 June 2022

2.6 Destruction Strength Measurement Experiment of Porous Seedling Pot

2.6.1 Method

The normal temperature compression molding and heating compression molding porous seedling pots were placed on the experimental platform of an electronic universal testing machine (WDW-200EIII, Jinan Times Test Gold Testing Machine Co., Ltd. Jinan, China), which complies with the GB/T16491-2008 standard. Using unconstrained support, through three-point bending (Fig. 6), the porous seedling pot of the sample was destroyed at a constant loading rate of 10 mm/min, the end position was set to 6 mm at the closed-loop control, and the holding time was 10 s. Throughout the process, the load applied to the specimen and the specimen deflection are measured to determine the flexural strength, flexural modulus of elasticity, and flexural stress-strain relationship. Adjust the span (L) and the position of the upper indenter to be accurate to 0.5mm. The L used in this experiment is 210mm. Place the upper indenter in the middle of the support and make the axis of the upper indenter and the cylindrical surface of the support parallel. The test is based on the provisions of GB/T1449-2005. Place the sample symmetrically in the middle of the support beam, pre-press the indenter on the surface of the sample, check the instrument to ensure that the entire system is in a normal state, and start the test after clearing the load and displacement. After reaching the target position, click stop and record the data. Click reset, when the displacement is zero, place a new sample and repeat the above steps. The porous seedling pots after the seedlings were raised were measured in the same way.

Fig 6: Three-point bending porous seedling pot failure experiment

2.6.2 Measurement results and discussion of universal testing machine

Fig. 7 shows the test results of the flexural strength of the MC3 and MC4 materials at room temperature for compression molding and hot-pressing molding of porous seedling pots. It can be seen from the figure that the porous seedling pots formed by hot pressing have better toughness and little difference in strength compared with room temperature compression molding for materials with the same moisture content. After the hot-pressed porous seedling pot is used for raising seedlings, the flexural strength of the porous seedling pot formed with the material MC3 is higher than that of the porous seedling pot formed with the material MC4.

Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
May-June 2022 Page No. 363-376
Article History: Received: 24 February 2022, Revised: 05 April 2022, Accepted: 08 May 2022, Publication: 30 June 2022

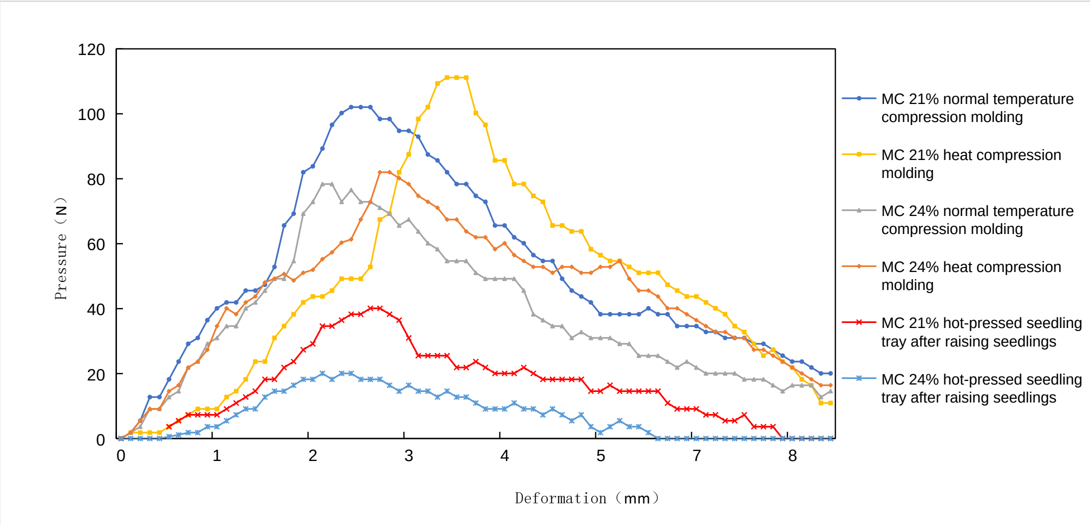

Fig 7: Experimental results of flexural strength of porous seedling pots of MC3 and MC4 materials compressed at room temperature and heated by compression molding

2.7 Electron microscope scanning test of molding material

2.7.1 Method

Take a 10×10mm porous seedling pot surface sample, put the peeled side of the sample up and stick it on the sample stage with double-sided tape, and place it in a DII-29030SCTR ion sputtering instrument (JEOLLTD.Tokyo, Japan) for 2×30s gold spray treatment. Then, the gold-sprayed samples were placed in a scanning electron microscope (SEM, JCM-6000, JEOL, LTD. Tokyo, Japan) together with the sample stage for sample observation. The accelerating voltage for SEM was set to 15 kV.

2.7.2 Electron Microscope Scanning Results and Discussion

Figure 8 shows the SEM image of the porous seedling pot. The fibrous material in the picture is the crop stalk fiber in the cow dung that has not been completely digested by the cow, and is mainly composed of lignin and cellulose. The irregularly shaped part marked in the figure is the impurities in cow dung are mainly composed of cow gastrointestinal secretions and undigested lignin (Fanetal. 2006). Figures 8A and 8B are SEM images of a sample of a porous seedling pot by compression molding at room temperature. A large number of stalk fibers in the cow dung are stacked and inlaid together. Compared with the MC4 material, the MC3 material has a smaller gap between the stalks after molding and drying. The SEM images of the hot-pressed porous seedling pot samples are shown in Figures 8C and 8D. In Figure 8C, most of the gaps between the stalk fibers are filled and adhered by the precipitated lignin in the stalk fibers, and most of the stalk fibers are laminated and inlaid with lignin. After the MC4 material was hot-pressed and formed (Fig. 8D), the phenomenon of lignin filling and adhesion between the fibers of the stacked stalks also appeared. Some gaps were not filled and adhered, and the laminated mosaic structure of the stalk fibers was relatively covered by lignin.

The inter-cellulose gap shown in the SEM image is produced by the internal stress of the material and

Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
May-June 2022 Page No. 363-376
Article History: Received: 24 February 2022, Revised: 05 April 2022, Accepted: 08 May 2022, Publication: 30 June 2022

the moisture in the material. During the compression process, due to the uneven volume change of the microstructure in the material, there is still residual stress inside. When the external load disappears, the There is a gap in the material after molding. After the lignin in the material is precipitated, the adjacent material fibers form a new whole. After the external load disappears, most of the internal stress is offset by the bonding force of the lignin. Therefore, the expansion rate and void ratio of the hot-pressed porous seedling pot after molding are the same. Smaller than NYPM porous seedling pots. During the compression process, the moisture in the material participates in the filling of the voids. After drying, the moisture evaporates to form a void in the material. The higher the moisture content of the material, the larger the void after drying. Therefore, the voids between the stalk fibers in Figures 8B and 8D are larger than those in Figures 8A and 8C. Gap between stem fibers. The mechanical inlaying force of the material is generated by the stacking and extrusion of the materials, so the larger the material gap, the smaller the mechanical inlaying force. In the above universal testing machine experiment, the flexural strength of the material MC3 molding porous seedling pot is higher than that of the MC4 material molding Porous seedling pot is also due to Caused by this.

The flow of lignin inside the material is divided into two stages. In the first stage, after the lignin in the stalk fiber reaches the softening temperature, it flows and precipitates under the action of internal pressure, filling the gaps between adjacent stalk fibers. The higher the lignin filling rate of the gaps between the stalk fibers, the better the integrity of the porous seedling pot, the better the adhesion effect of lignin, and the stronger the toughness of the porous seedling pot after molding; in the second stage, as the temperature increased, The mobility of lignin is improved, and the lignin in the gap will overflow and cover more adjacent culm fibers, forming a lignin layer outside the laminated mosaic structure of culm fibers. In the whole process, because the fluidity of water is higher than that of liquefied lignin, after the biomass material is compressed and the internal air is discharged, the moisture in the material will preferentially fill the gap between adjacent stalk fibers, and the lignin will adhere to the stalk fibers. Therefore, higher moisture content reduces lignin adhesion and film formation while increasing the material flow rate.

Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
May-June 2022 Page No. 363-376
Article History: Received: 24 February 2022, Revised: 05 April 2022, Accepted: 08 May 2022, Publication: 30 June 2022

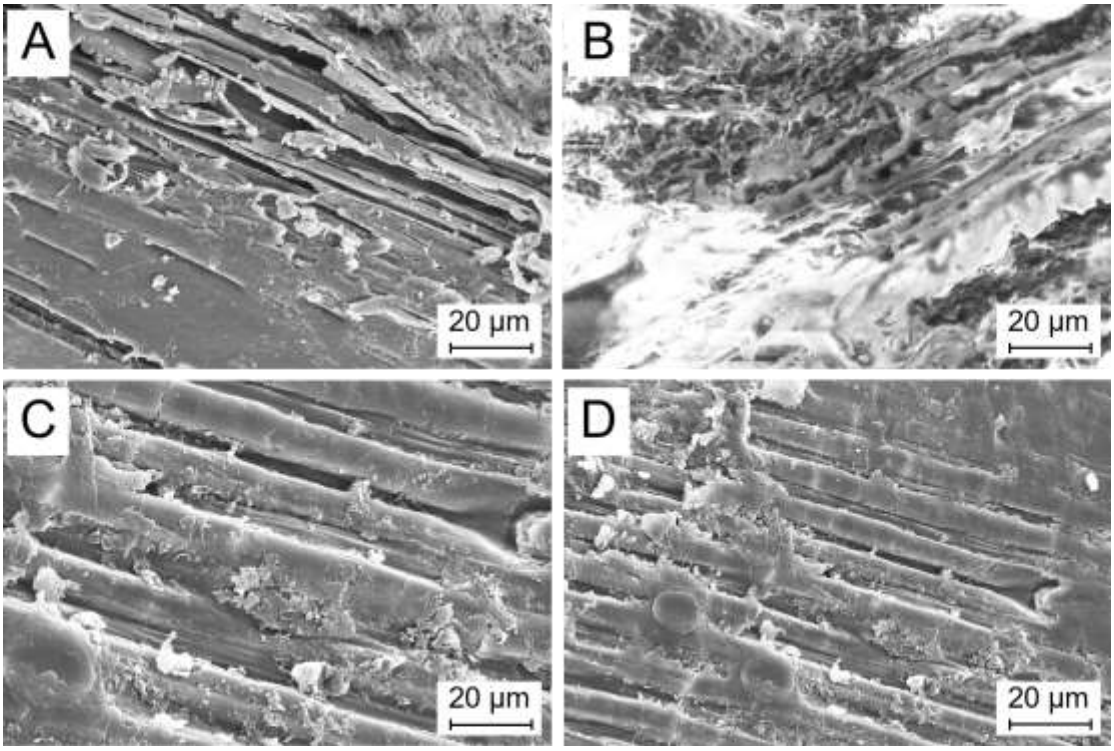

Fig 8: SEM image of the porous seedling pot

Fig. 9 is the SEM image of the porous seedling pot after raising seedlings. Figs. 9E, 9F, 9G and 9H are the SEM images of MC3 material room temperature compression molding, MC4 material room temperature compression molding, MC3 material hot pressing molding and MC4 material hot pressing molding porous seedling pot. image. In Figure 9E, the laminated mosaic structure of the stem fibers is seriously damaged, and the figure shows that the laminated mosaic part of the stem is less than one-sixth of the whole; Figure 9F shows that the laminated mosaic structure is completely destroyed, and the stem fibers are in a scattered and fluffy state; MC21% material After the seedlings are raised in the porous seedling pot, the stalk fiber layered mosaic structure can still be clearly observed by SEM (Fig. 9G), and a small amount of the stacked mosaic structure is destroyed; in Fig. 9H, the stem layered mosaic structure is more seriously damaged by water, and the stem fibers have a large area fracture.

During the seedling raising process, the water content in the seedling soil is relatively high. After the porous seedling pot is compressed at room temperature, the water will flow from the inside to the inside of the gap between the stalk fibers in the porous seedling pot due to the adhesion and cohesion of the molecules. Slow flow outside, larger gaps will increase the rate of water penetration. The MC3 material is compressed at room temperature and the porous seedling pot is relatively small because of the relatively small gap between the stalk fibers and the infiltration process is relatively slow. Therefore, the damage degree of the porous seedling pot after the seedling raising is less than that of the MC4 material. Cellulose has the property of swelling and swelling after absorbing water (Espert.etal.2004), so the infiltration process of water will cause the expansion of cellulose in the porous seedling pot, and the mechanical inlay force will be destroyed. The stress intersection occurs at the connection between the side wall of the bowl

Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
May-June 2022 Page No. 363-376
Article History: Received: 24 February 2022, Revised: 05 April 2022, Accepted: 08 May 2022, Publication: 30 June 2022

and the hole separator, which causes fracture damage. Most of the gaps between the stem fibers of the hot-pressed porous seedling pot are adhered by lignin, and the lignin will not be lost with water after drying, and the lignin filled in the gaps hinders the process of water capillary penetration. The lamination and mosaic structure inside the hot-pressed porous seedling pot of MC3 material is wrapped in a large amount by lignin, which isolates cellulose and water, so that the phenomenon of swelling does not occur, and the stacked mosaic of stems is protected from damage. The laminated mosaic structure inside the MC4 material hot-pressed porous seedling pot is wrapped in a small area. Although the lignin adhered between the adjacent stem fibers can slow down the penetration of water, it does not completely isolate the water from contacting with cellulose, so it is porous when exposed to water. The seedling pot expands, and at the same time, part of the water will infiltrate into the incompletely filled gap, causing the internal swelling of the stalk fiber to cause swelling and cracking, reducing the strength of the porous seedling pot. This part of the study verifies the above speculation about the strength of the porous seedling pot.

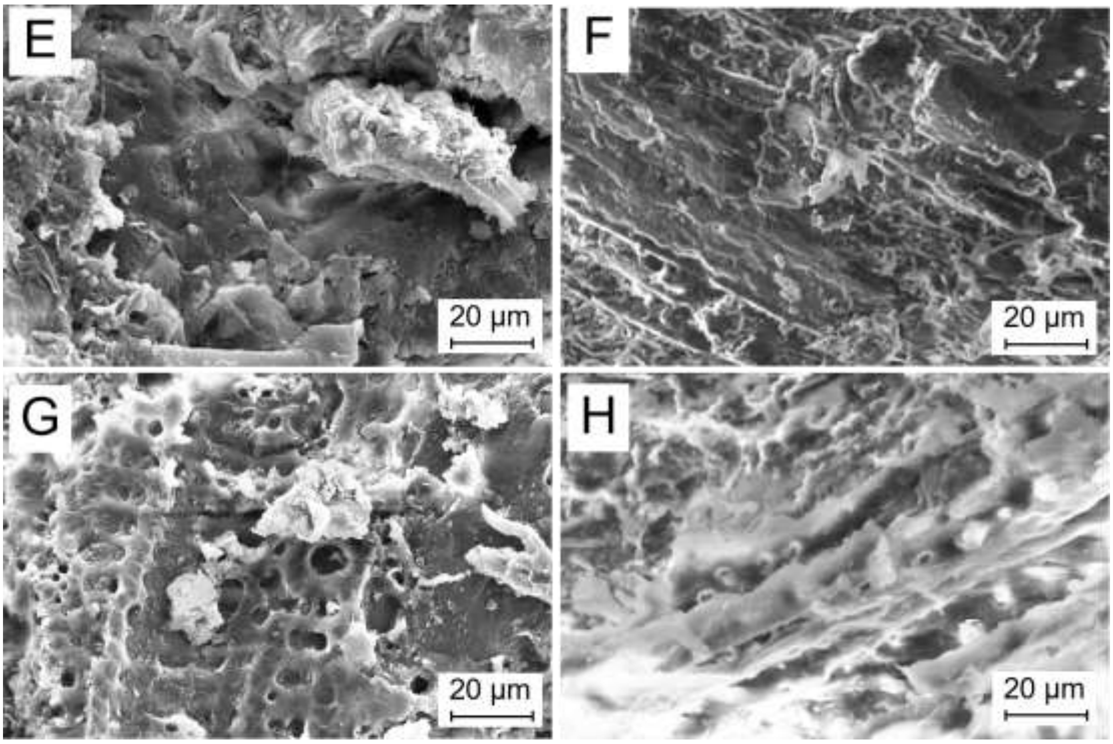

Fig 9: SEM image of the porous seedling pot after seedling raising

III. CONCLUSION

The bonding mechanism of biomass autologous lignin was analyzed. When the biomass material was compressed, the gap between the cow dung particles and the straw gradually became smaller. With the increase of the compression degree, the air in the gap was squeezed out, the material was compacted, and the cow dung was reduced. The granules and straw are deformed and inlaid together under extrusion. As the temperature increases, the fluidity of lignin increases, and the lignin mixed between cellulose and hemicellulose in the biomass material is under the action of pressure, along with the further compression of the material, the lignin is removed from the cellulose and hemicellulose.

Extrusion precipitation. The biomass material contacting the inner wall of the mold is the first to receive the temperature from the mold, and the lignin on the outer surface of the molding material first reaches a state of softening and liquefaction. Therefore, under the action of internal stress, the lignin in the biomass material contacting the inner wall of the mold The lignin is first extruded and precipitated, and fills the gap between the biomass material and the inner wall of the mold. A layer of lignin film is formed between the material and the inner wall of the mold. As the temperature decreases, the temperature of the compressed biomass material is lower than the glass transition temperature of the lignin, the lignin in the biomass material loses its fluidity and is re-plasticized into a crystalline state, and the lignin layer on the outer surface of the biomass molding material also solidifies Stable, after the pressure is removed, the biomass material can be stably fixed under the dual action of its own lignin binding and wrapping. The forming mechanism of the biomass seedling tray was revealed through the forming test of the biomass seedling tray and the electron microscope analysis. The stalk fibers in the material were compressed together to form a laminated mosaic structure. The mechanical mosaic force generated by the lamination of the stalk fibers was the main source of the strength of the seedling tray itself. ; The temperature of the mold increases to make the lignin in the material reach the softening temperature. After the lignin is precipitated under the action of internal stress, it adheres to the adjacent stalk fibers to form a new whole. There are many adjacent stalk fibers, and at the same time, a lignin layer is formed on the outside of the stalk fiber laminated mosaic structure; when the material temperature is lower than the glass transition temperature of the lignin, the seedling tray is formed.

The innovation of this study is to reveal the forming mechanism of biomass using autologous lignin to form seedling trays, and to propose a method for the development of biomass trays without the addition of external binders. The strength requirements of seedling transplanting and the addition of chemical binders are mainly focused on the mechanism of biomass utilization of autologous lignin to bonding and the influence and regularity of the performance indicators of biomass seedling trays. In the future, we will further study the research on the industrialized forming law of biomass seedling trays based on the research results.

ACKNOWLEDGEMENTS

This research was supported by China National Soybean Post System Platform, Talent Research Startup Plan of Heilongjiang Bayi Agricultural University (No. XYB201919), Study on Preparation Method and Forming Mechanism of Corn Transplanting Biomass Seedling Pan (Grant No. LH2019E073) of Heilongjiang Natural Science Fund Project, the innovative talent team of Heilongjiang Bayi Agricultural University, and Heilongjiang Bayi Agricultural University Agricultural Engineering Postdoctoral Station.

REFERENCES

[1] Tumuluru, J. S. (2018). Effect of pellet die diameter on density and durability of pellets made from high moisture woody and herbaceous biomass. Carbon Resources Conversion, 1(1), 44-54.

Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
May-June 2022 Page No. 363-376
Article History: Received: 24 February 2022, Revised: 05 April 2022, Accepted: 08 May 2022, Publication: 30 June 2022

[2]Yongcai, M., Wei, Z., Chun, W., Xin, M., Bo, Z., & Haiyang, W. (2016). Seedling-growing tray made of rice straw for maize seedling transplantation and its shear mechanics test. International Journal of Agricultural and Biological Engineering, 9(6), 44-55.
[3]Chaves, A., Waghorn, G. C., & Tavendale, M. H. (2018). A simplified method for lignin measurement in a range of forage species. In Proceedings of the Conference-New Zealand Grassland Association, (pp. 129-134).
[4]Maximova, N., Österberg, M., Koljonen, K., & Stenius, P. (2016). Lignin adsorption on cellulose fibre surfaces: effect on surface chemistry, surface morphology and paper strength. Cellulose, 8(2), 113-125.
[5]Lin, S. Y., & Dence, C. W. (Eds.). (2012). Methods in lignin chemistry. Springer Science & Business Media.
[6]Fang X. F., (2018) Current status and development trend of transplanting machinery technology in China. Agricultural machinery, 10(1), 35-36.
[7]Lianhao, L., Chun, W., Xinyue, Z., & Guangyong, L. (2018). Improvement and optimization of preparation process of seedling-growing bowl tray made of paddy straw. International Journal of Agricultural and Biological Engineering, 7(4), 13-22.
[8]Yongcai, M., Wei, Z., Chun, W., Xin, M., Bo, Z., & Haiyang, W. (2019). Seedling-growing tray made of rice straw for maize seedling transplantation and its shear mechanics test. International Journal of Agricultural and Biological Engineering, 9(6), 44-55.
[9]Zhang J. Z., & Zhang Y. (2000). A breakthrough in new technologies for high yield of corn - plastic floppy disk seedling transplanting. Tianjin Agriculture and Forestry Science and Technology, (5), 11-12.
[10]Feng J., Song W.T., & Liu Y.J. (2002). Discussion and practice of mechanization of corn plastic floppy disk seedling transplanting. China Agricultural Technology Promotion, 1, 049.
[11]Zhao X. M., & Gong Y.S. (2019). Feeding value and research prospects of livestock and poultry manure reclaimed feed. Journal of Animal Husbandry and Veterinary Medicine, 19(2), 20-22.
[12]Abubakar, B. S. U. I., & Ismail, N. (2018). Anaerobic digestion of cow dung for biogas production. ARPN journal of engineering and applied sciences, 7(2), 169-172.
[13]Espert, A., Vilaplana, F., & Karlsson, S. (2019). Comparison of water absorption in natural cellulosic fibres from wood and one-year crops in polypropylene composites and its influence on their mechanical properties. Composites Part A: Applied science and manufacturing, 35(11), 1267-1276.
[14]Sammond, D. W., Yarbrough, J. M., Mansfield, E., Bomble, Y. J., Hobdey, S. E., Decker, S. R., & Vinzant, T. B. (2014). Predicting enzyme adsorption to lignin films by calculating enzyme surface hydrophobicity. Journal of Biological Chemistry, jbc-M114.
[15]Xiao, Z., Li, Y., Wu, X., Qi, G., Li, N., Zhang, K., ... & Sun, X. S. (2019). Utilization of sorghum lignin to improve adhesion strength of soy protein adhesives on wood veneer. Industrial crops and products, 50, 501-509.
[16]Fan Xia, Han Lujia, Huang Caijin, & Huang Guangqun. (2018). The method of the composition determination of cow manure based on the near-infrared spectroscopy (nir). International Journal of Agricultural and Biological Engineering, 9(6), 16-28.