An Investigation into the Urea Absorption Efficiency of Absorbent Pads Derived from Corn Cobs

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Abstract

This study aims to investigate the urea adsorption efficiency of absorbent pads made from corn cobs and chitosan, and to examine the adsorption performance of these materials. Corn cobs obtained from farmers were used in the experiment. The study was divided into two parts. In the first part, absorbent pads were fabricated from corn cobs and chitosan, combined with corn starch. The corn cobs were ground into the smallest possible particle size. Then, an appropriate formulation was determined to produce absorbent pads that could maintain their structural integrity. The ratio of corn cobs to chitosan was 100 grams to 00 grams.

In the second part, urea adsorption was tested by immersing the absorbent pads into containers containing urea solutions of known concentrations. The concentrations tested were 00, 00, and 00, with a contact time of 15 minutes. After that, the absorbent pads were removed, and the remaining urea solution was titrated to determine the residual concentration after adsorption by the corn cob–chitosan absorbent pads.

Keywords: corn cobs, chitosan, corn starch, urea adsorption, bioadsorbent

Introduction

Absorbent pads are materials designed to absorb liquids such as water and urine. They are widely used, particularly for patients, infants, and pets, making them essential products in daily life with continuously increasing demand. However, commercially available absorbent pads are generally manufactured from synthetic materials that are difficult to biodegrade, resulting in long-term solid waste accumulation and environmental pollution. In addition, these materials may cause allergic reactions or skin irritation in some users. Therefore, there is growing interest in developing absorbent pads from natural materials or agricultural waste, particularly corn cobs, which are abundant agricultural residues in Thailand. Corn cobs are commonly disposed of by open burning or landfilling, leading to environmental problems such as air pollution and greenhouse gas emissions. Nevertheless, corn cobs have great potential as a biomass resource because they are mainly composed of cellulose, hemicellulose, and lignin, which form a fibrous structure with excellent liquid absorption properties.capable of effectively adsorbing certain substances. In addition, corn cobs possess a porous structure, a high surface area, and functional groups such as hydroxyl, carboxyl, and methoxy groups, all of which contribute to the adsorption of contaminants.

However, corn cobs alone have limitations in adsorbing urea from urine. Therefore, chitosan was incorporated as a component of the absorbent pad. Chitosan is a positively charged polysaccharide that can effectively bind to various substances, including urea. Its porous and fibrous structure enhances urea retention, while its amino groups can form hydrogen bonds with urea, further improving adsorption efficiency. Moreover, chitosan is a natural, non-toxic, and affordable material.

Based on this concept, this study aims to develop an absorbent pad composed of corn cobs and chitosan to increase the value of agricultural waste, reduce biomass waste, and provide an environmentally friendly alternative for the production of absorbent materials.

Methodology

Part 1: Preparation of Absorbent Pads from Corn Cobs and Chitosan

1.1 Raw Material Preparation Dried corn cobs were washed thoroughly to remove impurities and then air-dried until completely dry. The dried corn cobs were subsequently ground into fine particles using a grinder or blender.

1.2 Cellulose Fiber Extraction The ground corn cob powder was immersed in a 5% sodium hydroxide ($NaOH$) solution and heated at 80–90°C for 2–3 hours to remove lignin and hemicellulose. The treated material was then filtered and washed repeatedly with distilled water until a neutral pH was achieved. This process yielded cellulose fibers (corn cob fiber pulp).

1.3 Preparation of the Absorbent PadThe extracted corn cob fibers were mixed with 50 g of cooked corn starch paste and a chitosan solution at predetermined ratios. The formulations were prepared by mixing 150 g of dried corn cob fibers with different amounts of chitosan as follows:

Formulation 1: 150 g corn cob fibers : 0.5 g chitosan

Formulation 2: 150 g corn cob fibers : 1.0 g chitosan

Formulation 3: 150 g corn cob fibers : 1.5 g chitosan

Each mixture was stirred thoroughly until a homogeneous paste with suitable viscosity for molding was obtained.

1.4 Molding The prepared mixture was poured into a mold lined with a fine mesh and spread evenly to obtain a uniform thickness.

1.5 Pressing The molded mixture was compressed to remove excess water and increase the density of the absorbent pad. This pressing process enhanced the bonding between the corn cob fibers and chitosan, resulting in a stronger pad with improved structural integrity after drying.

1.6 DryingThe molded pads were carefully removed from the mold and placed on a drying rack. They were dried in a hot-air oven at 40–60°C or under direct sunlight until completely dry. Slow and uniform drying was carried out to prevent cracking and ensure consistent quality.

1.7 Cutting and Storage After the absorbent pads were completely dried, they were cut into the desired dimensions and stored in a dry, moisture-free environment to preserve their adsorption properties.

Part 2: Urea Adsorption Test

2.1 Preparation of Urea Solution 9.3 g/100 mL urea solution was prepared by accurately weighing 9.3 g of pure urea using an analytical balance. The urea was transferred into a beaker and dissolved in approximately 50–60 mL of distilled water. The solution was then transferred to a 100 mL volumetric flask, and distilled water was added until the liquid level reached the calibration mark. The flask was sealed and inverted several times to ensure complete mixing and a homogeneous solution. The preparation was repeated three times.

2.2 Preparation for Titration The titration apparatus was assembled, and a standard hydrochloric acid (HCl) solution was prepared and filled into a burette. Phenolphthalein solution was prepared as the indicator. Erlenmeyer flasks and pipettes were also prepared for the titration procedure.

2.3 Urea Adsorption Test The prepared urea solution was divided equally into three trays. Absorbent pad samples containing different chitosan formulations were immersed separately in the trays and allowed to stand for 5 minutes. After immersion, the absorbent pads were removed, and any physical changes in each sample were carefully recorded. The remaining urea solution was then analyzed by the titration method to determine the residual urea concentration and evaluate the urea adsorption efficiency of each absorbent pad formulation.

Result and Discussion

This study developed absorbent pads from corn cobs and chitosan to evaluate their liquid absorption capacity and urea adsorption efficiency. Three formulations containing different amounts of chitosan (0.5 g, 1.0 g, and 1.5 g) were prepared and tested using a 9.3 g/100 mL urea solution. The absorbent pads were immersed in the urea solution for 5 minutes, after which the remaining urea concentration was determined by acid–base titration.

1.1 Physical Characteristics of the Absorbent Pads After molding and drying, all absorbent pad formulations successfully maintained their structural integrity. The physical characteristics of each formulation were as follows:

Table 1 Physical Characteristics of the Long Sub Sheet

Chitosan Concentration	Characteristics of the Absorbent Pad
0.5 g	Relatively soft texture, loose structure, and rapid absorption.
1.0 g	Moderately dense structure, strong, and non-brittle.
1.5 g	Dense and firmer structure, with a slightly slower absorption rate.

According to Table 1, the physical characteristics of the absorbent pads containing different concentrations of chitosan were evaluated. The results showed that increasing the chitosan content resulted in a denser and more rigid pad structure. Pads with lower chitosan concentrations were softer and exhibited greater porosity, allowing for faster liquid absorption. In contrast, pads with higher chitosan concentrations were more compact and rigid, which slightly reduced their liquid absorption capacity.

1.2 Liquid Absorption Capacity

Observations indicated that all absorbent pad formulations were capable of absorbing the test solution. The fibrous structure of the corncob material facilitated the uptake of liquid into the pads, while the pads maintained their structural integrity without disintegration after being immersed for 5 minutes.

1.3 Urea Adsorption Results (Titration Analysis)

Titration of the remaining solution after the adsorption test showed a decrease in the residual urea content. The results indicated that increasing the chitosan concentration enhanced the reduction of urea in the solution after testing, suggesting that the chitosan content influenced the urea adsorption efficiency of the absorbent pads.

Table 2 Volume of HCl Used in the Titration

Chitosan Amount (g)	Trial 1 (mL)	Trial 2 (mL)	Trial 3 (mL)	Trial 1 (mL)
0	10.10	10.26	9.98	10.11
0.5	8.62	8.57	8.77	8.65
1.0	6.49	6.54	6.54	6.61
1.5	5.37	5.76	5.60	5.58

Table 2 presents the volume of hydrochloric acid (HCl) used to titrate the urea solution after the adsorption process. The results showed that the volume of HCl required for titration decreased as the amount of chitosan increased. The control sample (0 g chitosan) required the highest volume of HCl, whereas the sample containing 1.5 g of chitosan required the lowest volume. This indicates that the amount of urea remaining in the solution decreased with increasing chitosan content, suggesting that a higher chitosan content enhanced the adsorption efficiency of the absorbent pad.

Table 3 Percentage of Urea Adsorption

Calculated using the following formula:

$$\%Adsorption = \frac{V_{control} - V_{sample}}{V_{sample}} \times 100$$

Amount of Chitosan (g)	Average HCl Volume (mL)	Urea Adsorption (%)	Average Urea Adsorption (%)
0	10.11	0.00	0%
0.5	8.65	14.44	14.4%
1.0	6.61	34.62	34.6%
1.5	5.58	44.81	44.8%

Table 3 presents the percentage of urea adsorption by the absorbent pads. The results showed that the percentage of urea adsorption increased significantly as the amount of chitosan increased. The absorbent pad containing 1.5 g of chitosan exhibited the highest adsorption percentage, followed by those containing 1.0 g and 0.5 g of chitosan, respectively. These findings indicate that chitosan plays an important role in improving the urea adsorption efficiency of the absorbent pad.

Conclusion

The results of this study demonstrated that an absorbent pad made from corn cobs could be successfully fabricated by combining cellulose fibers extracted from corn cobs with wet corn starch adhesive and chitosan. The corn cobs were first treated with a 5% sodium hydroxide (NaOH) solution to obtain cellulose fibers, which were then mixed with different amounts of chitosan (0, 0.5, 1.0, and 1.5 g) before being molded and dried in an oven. The fabricated absorbent pads exhibited good structural integrity and were capable of absorbing liquids effectively.The physical properties of the absorbent pads varied with the amount of chitosan. The pad containing **0.5 g** of chitosan had a relatively soft texture with a loose structure, resulting in rapid liquid absorption. The pad containing 1.0 g of chitosan showed a moderately dense structure and good mechanical strength without brittleness. In contrast, the pad containing 1.5 g of chitosan had a denser and firmer structure, resulting in a slightly slower absorption rate but improved structural stability. The urea adsorption performance was evaluated by immersing the absorbent pads in a 9.3 g/mL urea solution for 5 minutes, followed by titration of the remaining solution with hydrochloric acid (HCl). The results showed that the volume of HCl required for titration decreased as the chitosan content increased, indicating that less urea remained in the solution after adsorption. Similarly, the percentage of urea adsorption increased with increasing chitosan content. The absorbent pad containing 1.5 g of chitosan exhibited the highest adsorption efficiency, followed by the 1.0 g and 0.5 g formulations, while the control (0 g) showed the lowest performance.

Overall, this study demonstrates that agricultural waste from corn cobs can be converted into biodegradable absorbent pads with effective liquid and urea adsorption properties. The addition of chitosan significantly enhanced the adsorption efficiency, with 1.5 g of chitosan providing the best overall performance. These findings suggest that corn cob–based absorbent pads have strong potential as environmentally friendly alternatives to conventional synthetic absorbent materials.

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References

Department of Agriculture. *Corn Cobs and Their Utilization*. Retrieved December 11, 2025, from https://www.doa.go.th

Faculty of Science, Mahidol University. *Biopolymers and Their Applications*. Retrieved April 10, 2026, from https://www.sc.mahidol.ac.th

Chulalongkorn University. *The Use of Biomass Materials for Adsorption*. Retrieved December 13, 2025, from https://www.chula.ac.th

Kasetsart University. (n.d.). *Agricultural Waste Materials and Their Utilization*. Retrieved December 9, 2025, from https://www.ku.ac.th

Thailand Institute of Scientific and Technological Research (TISTR). (n.d.). *The Use of Biomass Materials for Adsorption*. Retrieved December 9, 2025, from https://www.tistr.or.th