Evaluating the market chances of nano-cellulose for surface absorption of heavy metals

ABSTRACT

Today, various pollutants enter the environment due to the increase in human population and industrialization of society. One of these pollutants that have become a global form is heavy metals. Heavy metals that are produced due to the development of urbanization and industry and the increase in the amount of sewage and effluent enter the environment mainly through improper and unsanitary disposal of municipal wastewater and industrial effluent. Current research has evaluated water pollution with copper and lead metals by nano cellulose and nanocellulose modified with acrylic acid to absorb heavy metals. Heavy metal adsorption was identified when four main groups of benefits, costs, opportunities, and risks were classified. The importance of these main criteria was determined using the Analytic Hierarchy process. Results show nano cellulose modified with acrylic acid is the first priority, and nano cellulose not modified with acrylic acid is the second priority.

Keywords: Nanocellulose, Analytic Hierarchy Process, Adsorption, Benefits, Costs, Opportunities, Risks

1. Introduction

The development of urbanization and industries causes heavy metals to enter the environment through urban sewage and industrial effluents. In this research, considering the many capabilities and unique features of Nano-cellulose in the industry, we will examine the challenges and chances of this product's market and its ability to absorb heavy metals.

2. Literature Review

Agricultural waste and cellulosic products have been investigated as heavy metal absorbers due to cellulose as a biopolymer with renewable ability, high tensile and bending strength, and insolubility in solvents [Aoki et al., 2007]. Recently, researchers have investigated the characteristics and applications of a new form of cellulose, which are called by different names such as crystals, whiskers, nano-fibrils, and nano-fibers, and can create significant reactivity on the surface of cellulose (Klemm et al., 2011). In research, Azizi (2005) tested the decision-making model based on benefits, opportunities, costs, and risks by using Analytic Hierarchy Process for how to supply raw materials for a paper factory.

3. Hypotheses/Objectives

This research investigates the market chances of nano cellulose for surface absorption. The hypothesis is that the market chances of using nanocellulose modified with acrylic acid to remove heavy metals are more than nanocellulose without modification.

4. Research Design/Methodology

In this research, studying library documents and interviewing about the marketing of nano cellulose products, we identified influencing criteria in four general groups: benefits, costs, opportunities, and risks. After identifying the indicators, preparing a questionnaire, and collecting the opinions of 10 experts about the nanocellulose market and their application in the surface absorption of heavy metals, the Analytic Hierarchy Process, and Expert Choice software were used for data processing. Then we considered two options for market analysis to get their priority: nano cellulose modified with acrylic acid and nano cellulose not modified with acrylic acid.

5. Data/Model Analysis

The analysis of all **benefits** criteria showed that technical and human knowledge, economics, safety, and rules and regulations have weight values in the following order: 0.358, 0.285, 0.211, and 0.146. Therefore, having technical knowledge and a skilled workforce to produce acrylic acid-modified nanocellulose sheets can make a widely welcomed product. Regarding **costs** criteria, results show facilities and regional limitations, raw materials, economic conditions, and restrictions on species use have the following weighted values, respectively0.485 , 0.229, 0.152, and 0.135. Suppose each region has access to transit ways for transporting raw materials, an experienced workforce, easy access to cheap raw materials, etc. In that case, it can significantly reduce the costs of producing a product. The results of the **opportunities** index showed that job creation, with a weighting factor of 0.384, is in the first place, and less destruction of the environment and investment are in the second and third place with a weighting factor of 0.355 and 0.261. Job creation causes a lot of motivation for government managers to provide financial and educational support to production, and the development of new products accelerates. Finally, the prioritization order of the **risks** group showed that the index of lack of acceptance and recognition of the product with a weighted value of 0.401has the highest priority, and the index of the strength of competition with other similar products and decrease in sales and increase in costs with weighted values 0.373 and 0.227are the second and third priorities, respectively. The index of lack of acceptance and recognition of the product for the people of the social causes the customers not to welcome the product, and as a result, the product is not sold. Also, in many cases, the quality of the product does not meet the taste of the customers, and the sales decrease.

6. Limitations

Identifying people with high expertise in surface absorption and nano products was very difficult, and we faced many limitations. Nano products are a new topic; their use in industry and environmental pollution removal has been identified recently. For this reason, we met the limit of the number of experts with high expertise in this field to answer the proposed questionnaires.

7. Conclusions

One of the most critical pollutants in drinking water is the presence of heavy metals. The presence of these metals causes severe complications in the human body. After reviewing the sources and interviewing experts in this field, indicators influencing the evaluation of the market chances of nanocellulose for the absorption of heavy metals were identified. First, four main groups were determined, then the degree of importance of these criteria was determined using Analytic Hierarchy Process. The results showed that nanocellulose modified with acrylic acid is more important for marketing the absorption of heavy metals than unmodified nanocellulose. The test result also showed that the absorption rate of copper and lead metals using nano cellulose modified with acrylic acid is 97.62 %and 96.18 %, respectively.

On the other hand, the amount of absorption of copper metal and lead metal using nano cellulose without modification with acrylic acid is 82.43% and 58.9%, respectively. As the result of the test showed, in the first case, the percentage of absorption of heavy metals is higher. Therefore, the development of this test is consistent with the result of comparing the importance of these two options for market chances with the Analytic Hierarchy Process.

8. Key References

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