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THE PHYSICOCHEMICAL ACTIVITY OF CHITIN AND CHITOSAN OBTAINED BY THE CHEMICAL PROCESSING OF SHRIMP *Penaeus semisulcatus*

Ayman Younes Fathy Allam, postgraduate student, Astrakhan State Technical University, 16 Tatishcheva Str., Astrakhan, 414056, Russian Federation; Assistant Lecturer, Faculty of Agriculture, Minofiya University, Egypt, ayman.alaam@yandex.ru

Dolganova Natalia V., D.Sc. (Technical), Professor, Astrakhan State Technical University, 16 Tatishcheva Str., Astrakhan, 414056, Russian Federation, dolganova-natalya@yandex.ru

This paper was performed to achieve the optimum parameters involved in shrimp shell processing. The major procedure for obtaining chitosan is based on the alkaline deacetylation of chitin from shrimp shell *Penaeus semisulcatus* with a strong alkaline solution. Chitosan is a natural Bio-polymer derived by deacetylation of chitin, a major component of the shells of a crustacean such as a crab, shrimp, and crayfish. During the past several decades, chitosan has been receiving increased attention for its commercial applications in biomedical, food, and chemical industries. The obtained chitin was converted into the more useful soluble chitosan by stepping into solutions of NaOH of various concentrations and for extended periods of time, then the alkali chitin was heated which dramatically reduced the time of deacetylation. Chitin from squid pens did not require stepping in sodium hydroxide solution and showed much higher reactivity towards deacetylation of heating a degree of deacetylation of 90 % was achieved. Finally, the natural biological properties of chitin and chitosan are valuable for both plant and animal applications and such developments can be considered as valuable extensions of the use of chitin and its derivatives.

***Keywords*:** shrimp, physiological activity, properties of chitin, chitosan, polymer waste, food products

ФИЗИКО-ХИМИЧЕСКАЯ АКТИВНОСТЬ ХИТИНА И ХИТОЗАНА, ПОЛУЧЕННЫХ ПРИ ХИМИЧЕСКОЙ ПЕРЕРАБОТКЕ ИЗ КРЕВЕТКИ *PENAEUS SEMISULCATUS*

Аллам Айман Юнес Фатхи, аспирант, Астраханский государственный технический университет**,** Российская Федерация, 414056, г. Астрахань, ул. Татищева, 16, Assistant Lecturer, Faculty of Agriculture, Minofiya University, Egypt,ayman.alaam@yandex.ru

Наталья Вадимовна Долганова*,* доктор технических наук, профессор, Астраханский государственный технический университет, Россия, 414056, г. Астрахань, ул. Татищева, 16, dolganova-natalya@yandex.ru

Охарактеризованы структура и свойства природного полимера углеводной природы – хитина – и продукта его дезацетилирования – хитозана. Хитин является вторым наиболее важным природным биополимером в мире. Огромные суммы краба и раковин креветок остаются отходами международными компаниями морепродуктов. Это приводит к значительному научному и технологическому интересу к вторичному использованию хитина как попытке использовать эти уникальные возобновимые отходы. Отходы от обрабатываемых креветок главным образом состоят из голов, раковин и остаточного мяса, которые не используются человеком для производства продуктов питания. Значительная часть отходов – хитин – требует многих экономических затрат. Хитин добывается из разных традиционных гидробионтов. Наиболее подходящим, экономически обоснованным источником хитина

может стать креветка *Penaeus semisulcatus*. Этот вид гидробионтов представляет собой опасность загрязнения морской акватории. Особый интерес у нас вызывает исследование физиологической активности хитина и хитозана и его возможное применение в пищевой промышленности: улучшение огранолептических и вкусовых качеств пищевах продуктов.

Ключевые слова: креветки, физиологической активности, свойства, хитин, хитозан, полимером, отходы, пищевых продуктов

The reactive functional properties groups of chitosan contain an amino group and both primary and secondary hydroxyl groups at C-2, C-3, and C-6 positions, respectively. The amino contents of chitosan are the main factors preferring their structures and physical and chemical properties and are correlated with their chelation, flocculation, and biological functions [1; 9]. The antioxidant properties of chitosan have been studied in vivo and in-vitro. The antioxidant effects of chitosan on the oxidation process of crude rapeseed oil were demonstrated by Liu [2] who reported that chitosan could significantly reduce serum free fatty acids and elevate superoxide dismutase, malondialdehyde concentrations, and display catalase and glutathione peroxidase activities, the latter being the major antioxidant enzymes in the body. A major source for the production of a wide range of chitin and chitosan is crustacean processing waste (shrimp, krill, and crab shells). Physicochemical and structural properties of chitin and chitosan depend on both sources and production conditions. Shrimp is usually peeled in standard seafood processing factories to obtain shrimp meat for export, and unused shells and heads, approximately represent 35–45 % of the total weight, are considered to waste. Consequently, shrimp processing leads to huge amounts of shrimp bio-waste estimated to be more than 400,000 metric tons (wet weight) per year [3; 10]. To date, the shrimp waste has been used primarily for the preparation of chitin and chitosan. In addition to potential applications of chitin and the chitosan relies on their biological activities and physicochemical properties. However, information got from green shrimp waste relying on the physicochemical properties and the biological activities of chitin and chitosan which has been prepared from shrimp waste are limited. Chitin, a linear polymer of β-(1-4) linked 2-acetamido-2-deoxy-D-glucopyranose, it is one of the most abundant natural polymers and in almost all crustaceans.

•Extraction and Purification of Chitin

Chitin is currently within many taxonomic combinations. However, commercial chitosan is usually isolated from marine crustaceans, mainly because a large amount of waste is available as a by-product of their food processing. It happens in the skeletal substances crustaceans such as lobsters, crabs, prawns, shrimps, and crayfish. While much research has been done with chitosan extraction from shrimp shell, confined information is available on the extraction possibilities with shrimp and crawfish waste. Crustacean waste shells consist of 35−45 % proteins, 30−55 % calcium carbonate and 25−37 % chitin and contain pigments of a lipidic nature, such as carotenoids (astaxanthin, station, canthaxanthin, lutein, and β-carotene). These proportions vary with species and with the season. Several well-known procedures have been performed to remove these impurities. Demineralization, deproteinization, and deacetylation are the three traditional steps for the isolation of chitin. Demineralization and deproteinization are the two specific steps for the isolation of chitin, which involves the dissolution of calcium carbonate with HCl and the removal of proteins with NaOH, respectively. In most of the cases, deproteinization has been carried out before to demineralization.

•Deacetylation of Chitin

The physical and chemical characteristics of chitosan are the degree of deacetylation and its molecular weight. These parameters play a key role in the quality of chitosan in its different applications. The main difference between chitin and chitosan lies in their solubility. The degree of distillation is the ratio of Glucosamine monomer residues in chitin. Deacetylation has a striking influence on the solution properties of chitin and solubility. The degree of deacetylation could affect the performance of chitosan in many of its applications. It defines the content of free amino groups in the polysaccharides and can be employed to characterize among chitin and chitosan. The process of deacetylation includes the removal of acetyl groups from the molecular series of chitin, leaving behind a complete amino group (-NH2) and chitosan versatility depends mainly on this high degree chemical reactive amino group [4; 5]. One of the major reactions carried out on chitin is deacetylation, especially by using aqueous alkali. The most considerably used alkali has been NaOH. The level of deacetylation is governed by the alkali concentration, temperature, particle size, time of reaction, and density. While treatment with 10–15 % NaOH at 90–100 °C for 1–3 hour gives a product having 80–90 % deacetylation, extending the reaction time to 40–50 h enables almost 100 % deacetylation but at the expense of a considerable decrease in solution viscosity indicating series degradation. Because of this, the degree of deacetylation is a significant property in chitosan production as it affects the physical and chemical such as different potential and applications properties. Deacetylation also affects the biodegradability and immunological activity. This deacetylation determines its suitable applications in different fields of research.

•Chitosan-Based Coatings

Chitosan is a polymer with specific structure and properties and contains more than 5000 glucosamine units and is the second most abundant natural polymer after cellulose. Similar to the cellulose, chitosan is a fiber, but different from plant fiber, chitosan takes possession unique properties including the ability to form edible films. Because of positive ionic charge on chitosan, it has the ability to bind chemically with negatively charged fats, bile acids, and lipids. Chitosan has attracted major attention, not only because of being a resource that is underutilized, but also due to its biological behavior's, antioxidant, namely, hypocholesterolemic, antimicrobial, antitumor activity, immunity enhancing, drug delivery, its capacity accelerates calcium, ferrum absorption, and so forth. The antioxidant activities of chitosan have been studied in vivo and in-vitro. Antioxidant effects have been shown from chitosan on the oxidation of rapeseed oil by [6; 8] who reported that chitosan could significantly reduce malondialdehyde concentrations and elevated superoxide dismutase's, serum free fatty acids, and display catalase and glutathione peroxidase activities, the latter being the principal antioxidant enzymes in the body. One of those is chitosan. Chitosan is biocompatible, not antigenic, not nontoxic and bio-functional [7; 1].

•Edible Coatings

The use of edible coatings signifies one of the significant methods for preserving quality. Edible coatings have been traditionally utilized to improve food appearance and maintain quality because they are considered eco-friendly. Coating films can act as barriers to moisture and oxygen during processing, handling, and storage. Furthermore, they can retard food deterioration by inhibiting the growth of bacteria and all microorganisms, due to their natural essential activity or to the incorporation of antimicrobial compounds. Dips of antimicrobial solutions are commonly practiced to improve the microbial stability of fresh-cut fruit. However, these antimicrobial agents rapidly squander into the food, subsequently, reducing the efficacy due to a decrease in condensation on the fruit surface. The incorporation of antimicrobial agents into edible coatings provides more inhibitory effects pathogenic bacteria and against spoilage by maintaining effective concentrations of the active compounds on the food surfaces [9]. The use of edible coatings in combination with antimicrobial properties or with the amalgamation of antimicrobial compounds is a possibility alternative to enhance the safety and quality of fresh fruits. Chitosan coatings containing bergamot oil produced the most effective antimicrobial activity and showed the greatest inhibition of the respiration rates in terms of both O_2 consumption and Co_2 generation (Sánchez-González et al., 2011). Chitosan is one of the best examples of edible coatings for prolonging shelf-life of products, improving the quality and resistivity of the fresh cut fruits. Several types of edible coatings have been used for extending shelf-life of fresh commodities. A chitosan-based edible film has been used on strawberries to increase the shelf-life (Park et al., 2005). A reduction in the counts of coliforms microorganisms and aerobic was also observed during storage.Assis and Han also proposed chitosan for extending the shelf-life of fresh strawberries and sliced apples, respectively [10].

Conclusion

Because of numerous potential applications and properties, chitosan has gained a lot of attention. Antibacterial, antifungal and film forming properties of chitosan make it an ideal for use as biodegradable antimicrobial packaging material to improve the storability of perishable fruits. It is clearly demonstrated by numerous research that chitosan can be used as an effective preservative or coating material for the improvement of quality and shelf life of various fruits. Since chitosan application modified the respiration pattern of fruits, further research is underway to evaluate the effect of this treatment on the fruit flavor profile.

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НОВАЯ КАТАЛИТИЧЕСКАЯ СИСТЕМА ДЛЯ ОЧИСТКИ ВОЗДУХА ОТ МОНООКСИДА УГЛЕРОДА

Людмила Александровна Джигола, доцент, кандидат химических наук, Астраханский государственный университет, Российская Федерация, 414000, г. Астрахань, пл. Шаумяна, 1, djegola@mail.ru

Ксения Сергеевна Тихонова, магистрант, Астраханский государственный университет, Российская Федерация, 414000, г. Астрахань, пл. Шаумяна, 1, I_m_Ksushe4ka@mail.ru

Анна Станиславовна Реснянская, кандидат химических наук, доцент, Астраханский государственный архитектурно-строительный университет, Российская Федерация, 414056, Астрахань, ул. Татищева, 18, resnyanskya-as@yandex.ru

Данная статья посвящена поиску решения актуальной проблемы – очистке воздуха от угарного газа. В работе проанализированы существующие каталитические системы для очистки воздуха от монооксида углерода. На основе анализа их достоинств и недостатков предложены модифицированные (Cu, Mn, NH_3) катализаторы на основе минерального сырья (шамотная глина). Приводится описание установки для апробации работы созданных катализаторов в лабораторных условиях. Полученные результаты указывают, что наилучшей степенью очистки обладает система, содержащая диоксид марганца, сульфат меди и аммиак на минеральной основе. При работе данного катализатора одновременно протекают процесс окисления монооксида углерода в диоксид и процесс сорбции монооксида и диоксида углерода. Экспериментальные данные показали, что 6,8 % CO окисляется в CO_2, и суммарно 93,2 % CO поглощается медь-марганцевым катализатором. Приводятся уравнения протекающих реакций.

***Ключевые слова*:** монооксид углерода, диоксид углерода, очистка воздуха, каталитическое окисление, катализатор, титрование, эффективность работы катализатора, емкость катализатора, окисление, сорбция

A NEW CATALYST SYSTEM FOR AIR PURIFICATION FROM CARBON DIOXIDE

Dzhigola Lyudmila A., Ph.D. (Chemistry), Associate Professor, Astrakhan State University, 1 Shaumyana Sq., Astrakhan, 414000, Russian Federation, djegola@mail.ru

Tikhonova Kseniya S., undergraduate student, Astrakhan State University, 1 Shaumyana Sq., Astrakhan, 414000, Russian Federation, I_m_Ksushe4ka@mail.ru

Resnjanskaja Anna S., Ph.D. (Chemistry), Associate Professor, Astrakhan State University Of Civil Engineering, 18 Tatishcheva Str., Astrakhan, 414056, Russian Federation, resnyanskya_as@yandex.ru