Uluslararası İleri Doğa Bilimleri ve Mühendislik Araştırmaları Dergisi
Sayı 8, S. 350-354, 11, 2024

Araştırma Makalesi

IJANSER

https://as-proceeding.com/index.php/ijanser
ISSN:2980-0811

International Journal of Advanced Natural Sciences and Engineering Researches
Volume 8, pp. 350-354, 11, 2024

Research Article

Biodegradable Packaging Film Production Using Purple Flour and Tapioca Starch

Evren Arıöz[1] and Kaan Yıldız[1]

[1]*Department of Chemical Engineering, Eskisehir Technical University, Turkey*

(evrenbayram@eskisehir.edu.tr) Email of the corresponding author

(Received: 05 December 2024, Accepted: 09 December 2024)

(3rd International Conference on Recent Academic Studies ICRAS 2024, December 03-04, 2024)

ATIF/REFERENCE: Arıöz, E. & Yıldız, K. (2024). Biodegradable Packaging Film Production Using Purple Flour and Tapioca Starch. *International Journal of Advanced Natural Sciences and Engineering Researches*, 8(11), 350-354.

Abstract **–** In recent years, the excessive use of plastic packaging materials has increased environmental concerns. Petroleum-based packaging causes serious environmental problems both. To overcome these environmental problems, environmentally friendly and biodegradable packaging materials have been developed. Many natural polymeric materials can be used to produce biodegradable packaging materials. Among these polymers, flour and starch are the most preferred materials due to their low cost and abundance. In this study, purple flour and tapioca starch were used at percentages of 2% and 3% of the film solutions. The moisture content, moisture uptake, swelling index, surface pH and pH values of all the produced films were determined. The moisture uptake capacities of films with low moisture contents were high as expected. The highest moisture uptake was found as 55.5% for the film produced with purple flour that used at 2%. Surface pH and pH values determined after dissolution of the films were found to be close to neutral values. Swelling capacity values, which are a parameter indicating the stability of the films, were found to be very high in all films produced with flour and starch. The results showed that the films produced in experimental studies can be used as packaging materials by adding some features to the films.

Keywords – Biodegradable film, packaging, purple flour, tapioca starch

I. Introduction

In food industry, plastics are the most commonly used packaging materials [1]. Plastics are largely produced from non-renewable petroleum resources [2]. Therefore, enormous production of plastic causes serious pollution in the environment globally, hence non-biodegradable plastic packaging causes water and soil pollution [1,2]. As an alternative to synthetic plastics, biodegradable packaging that can break down naturally can be used in the food industry [3].

Polysaccharides, proteins and lipids, which are natural polymers, are frequently used in packaging material production. Starch is a natural polymer in the polysaccharide class and is a widely researched material for film production due to its properties such as easy and abundant availability, low cost and safety. Starch-based films are also biocompatible materials [4].

Starch-based biodegradable plastics account for approximately 66% of the global bioplastics market [5]. Starch-based films are applied as biodegradable packaging materials in the food industry involving fruits and bread. In the production of starch-based materials, the shelf life of food is extended by blending different components to enhance the oxygen and water vapor barrier and by adding antioxidants or antibacterial substances to the film solutions [2].

Wheat is one of the three major crops in the world [6]. Wheat contains major components that provide health benefits such as vitamins, dietary fibers, and phytochemicals [7]. Colored wheat varieties contain more bioactive compounds such as polyphenols and anthocyanins than normal wheat, thus providing health benefits [6].

Since flour is a natural mixture of starch, protein and fibers, it can be used in the production of films or coatings. The properties of the films produced from flour depend on the production conditions and the many molecular interactions that occur between the components [8].

In this experimental study, purple flour and tapioca starch were used for biodegradable packaging film synthesis. The physical properties were determined and compared to each other.

II. Materials and Method

A. Film Synthesis

Purple flour and tapioca starch were used in film synthesis. Flour and starch were obtained from market in Eskişehir, Turkey. The flour and starch were both added to distilled water at 2% and 3% by weight. Glycerin (1 wt%) was added as a plasticizer in all solutions. The film solutions were mixed at 60°C for 90 minutes. After homogenisation, film were cast into Petri dishes and dried at 50°C overnight.

B. Physical Properties of the Films

The moisture content, moisture uptake, swelling index, surface pH and pH values of all the films were determined.

For moisture content analysis, the films were cut and weighed (W0). The films were then dried in an oven at 105 °C until constant weight (W1) was reached. The moisture content of the films was calculated using the following equation [4]:

$$Moisture\ content\ (\%) = \frac{(W_O - W_1)}{W_O} x100 \qquad \text{(Eq.1)}$$

To determine the moisture uptake of the films, the samples were exposed to a humidity level of 99 ± 1% RH in a closed container. After 24 hours, the moisture retention capacities were determined as follows where W_f and W_i are the final and initial weights of the films, respectively:

$$Moisture\ uptake\ (\%) = \frac{(W_f - W_i)}{W_i} x100$$

The swelling indexes of four samples were determined for each sample. Initially, the dried films were weighed and immersed in deionized water at room temperature. At 10-min intervals, the samples were removed from the water and excess water was removed using filter paper. Then, the weights of the swollen films were measured. The swelling index was calculated as follows:

$$Swelling\ index\ (\%) = \frac{(m_f - m_i)}{m_i} x100$$

m_i is the initial weight of films and m_f is the swollen weight of the films [9].

The surface pH values of the films were determined. All films were moistened with 0.5 ml of distilled water and waited for 30 seconds. After, the electrode of the pH meter was brought into contact with the surface of the films and the pH values were noted [10].

The films were placed in tubes containing 2 ml of distilled water to determine the pH values. When the films were dissolved, the pH values of the films were determined by measuring them with a pH meter.

III. Results

The moisture content of the sample is the free water bound to the film [11]. The moisture contents of the samples are given Fig 1.

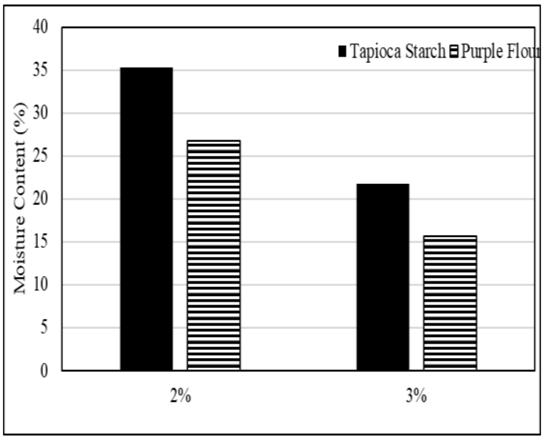

Fig.1. Moisture content of the films

As seen in the Figure, the moisture content of the films prepared with tapioca starch were higher than the films prepared with purple flour. The moisture contents of the films were decreased with increasing percentage of the starch and flour.

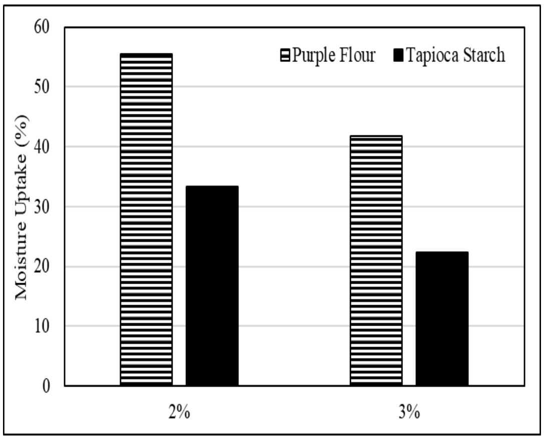

Fig.2. Moisture uptake of the films

The moisture uptake percentages of films produced with tapioca starch were found to be lower than those produced with purple flour. The less moisture uptake value was 22.2% for the sample prepared with 3% tapioca starch and the highest value was 55.5% for the sample prepared with 2% purple flour. The surface pH values of the films are given in Fig. 3.

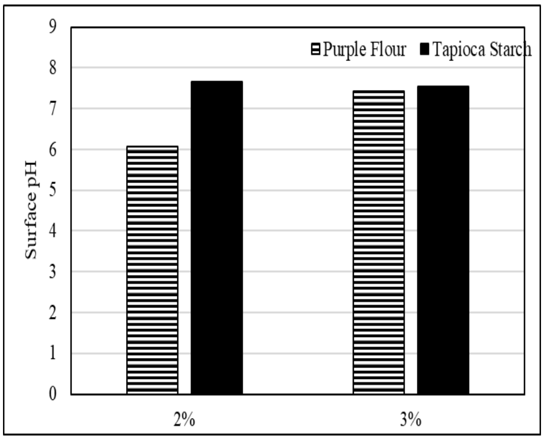

Fig.3. Surface pH values of the films

The surface pH values of the films produced with purple flour were lower than those produced with tapioca starch. The surface pH values increased as the percentage of the purple flour increased. The pH values of the films after the complete dissolution are given in Fig. 4.

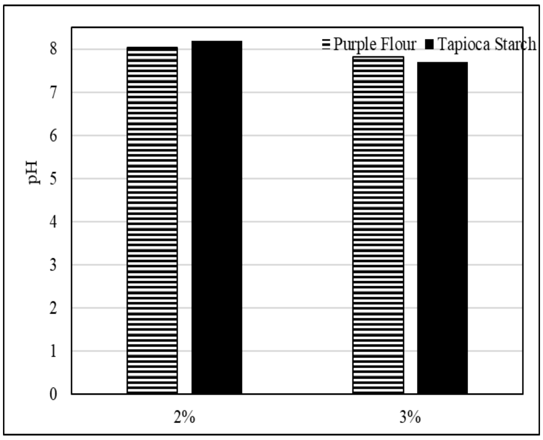

Fig.4. pH values of the films

The pH values of the films were slightly increased after the complete dissolution. The swelling index of the films prepared with purple flour and tapioca starch are given in Fig. 5. and Fig. 6.

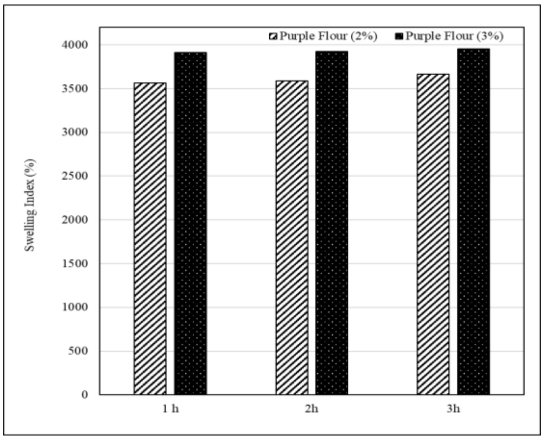

Fig.5. Swelling index of the films prepared with purple flour

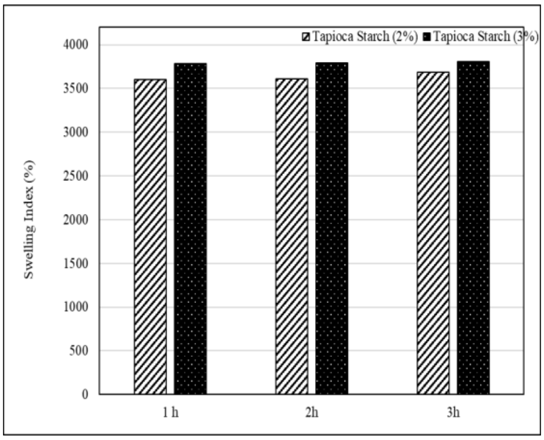

Fig.6. Swelling index of the films prepared with tapioca starch

Swelling index values were found to be very high at all rates for both types of films. High absorption mechanism demonstrates film network stability that minimizes phase separation changes [12].

IV. DISCUSSION

The moisture content of the films prepared with tapioca starch were higher than the films produced with purple flour and the values decreased with increasing flour and starch percentage. The moisture uptake percentages were found to be inversely proportional to moisture contents, as expected, meaning that films with low moisture content have high moisture uptake capacity. The high swelling index is a parameter that shows the film stability. The swelling indexes of the films obtained from experimental studies were found to be very high.

V. CONCLUSION

In this study, the usability of purple flour and tapioca starch as biodegradable raw materials in packaging production was investigated and the important physical properties of the films were determined. It was found that the moisture content of the films was high. The properties of the films can be improved by changing the formulation values. In addition, different additives such as plant extracts can be added to the film formulations to gain the films new properties such as antioxidant content.

REFERENCES

[1] W. Song, N. Wu, Y. He, H. Zhao, J. Xu and L. Ren, "Intelligent color changing packaging film based on esterified starch and black rice anthocyanins", Food Chemistry: X, vol. 24, Article 101930, December 2024.

[2] H. Cheng, L. Chen, D.J. McClements, T. Yang, Z. Zhang, F. Ren, M., Miao, Y. Tian and Z. Jin, "Starch-based biodegradable packaging materials: A review of their preparation, characterization and diverse applications in the food industry", Trends in Food Science & Technology, vol. 114, pp. 70-82, August 2021.

[3] S. Fatima, M.R. Khan, I. Ahmad and M.B. Sadiq, "Recent advances in modified starch based biodegradable food packaging: A review", *Heliyon*, vol. 10, Article e27453, March 2024.

[4] M. Uyarcan and S.C. Güngör, "Improving functional properties of starch-based films by ultraviolet (UV-C) technology: Characterization and application on minced meat packaging", *International Journal of Biological Macromolecules*, vol. 282(3), Article 137085, December 2024.

[5] N.H. Yusoff, K. Pal, T. Narayanan and F.G. de Souza, "Recent trends on bioplastics synthesis and characterizations: Polylactic acid (PLA) incorporated with tapioca starch for packaging applications", *Journal of Molecular Structure*, vol. 1232, Article 129954, May 2021.

[6] T. Zhang, H. Kim and M. Kweon, "Impact of kernel hardness and amylose content on quality characteristics of purple-colored whole wheat flour", *Cereal Chemistry*, vol. 101, pp. 1084–1093, June 2024.

[7] S.M. Awol, C.G. Kuyu, T.Y. Bereka and N. Abamecha, "Physicochemical stability, microbial growth and sensory quality of refined wheat flour as affected by packaging materials during storage", *Journal of Stored Products Research*, vol. 105, Article 102217, February 2024.

[8] A.I. Petaloti, S. Makri and D.S. Achilias, "Bioactive Edible Gel Films Based on Wheat Flour and Glucose for Food Packaging Applications", *Gels*, vol. 10(2), Article 105, January 2024.

[9] N. An and W. Zhou, "Sodium alginate/ager colourimetric film on porous substrate layer: Potential in intelligent food packaging", *Food Chemistry*, vol. 445, Article 138790, July 2024.

[10] P. Parabhu, R. Malli, M. Koland, K. Vijaynarayana, U. D'Souza, N.M. Harish, C.S. Shastry and R.N. Charyulu, "Formulation and evaluation of fast dissolving films of levocitirizine di hydrochloride", International Journal of Pharmaceutical Investigation, vol. 1(2), pp. 99–104, April 2011.

[11] K. Chowdhury, S. Khan, R. Karim, M. Obaid and G.M.M.A. Hasan, "Effect of Moisture, Water Activity and Packaging Materials on Quality and Shelf Life of Some Locally Packed Chanachur", *Bangladesh Journal of Scientific and Industrial Research*, vol. 46(1), pp. 33-40, 2011.

[12] A.A. Abdillah and A.L. Charles, "Characterization of a natural biodegradable edible film obtained from arrowroot starch and iota-carrageenan and application in food packaging", *International Journal of Biological Macromolecules*, vol. 191, pp. 618-626, Nov 2021.