BİYOBOZUNUR FİLM ÜRETİMİ VE KARAKTERİZASYONU

Mehmet Fatih ÖZDEMİR
Bilecik Sheikh Edebali University, Institute of Graduate Studies
ORCID ID: 0009-0009-2523-5707
Levemt DEĞİRMENCİ
Bilecik Sheikh Edebali University, Chemical Engineering Dept.
ORCID ID: 0000-0001-6608-0398

ÖZET

Biyobozunur filmler gıda muhafazasında yaygın olarak kullanılmaktadır. Gıda muhafazasında nihai hedef saklanacak ürünün son kullanım tarihine kadar tazeliğini korumasıdır. Bu kapsamda kullanılan filmlerin gıda ile bir arada kullanılabilmesi ve film malzemesinin başlı başlına kontaminasyon kaynağı olmaması bir gereklilik olarak ön plana çıkmaktadır. Film malzemesi seçiminde malzemelerin doğada parçalanır olması kadar önemli bir başka husus malzemeye farklı içerikler katılabilmesi ve buna bağlı olarak özelliklerinin değiştirilebilmesidir. Bu konuda yapılan çalışmalarda en fazla biyobozunur filme anti mikrobiyal özellik kazandırılması ile ilgili olanlar dikkat çekmiştir.

Sunulan çalışma biyobozunur filmlerin üretiminde en fazla kullanılan malzemeler arasında yer alan polivinil alkol (PVA) ve nişasta kullanılarak üretilen filmleri içermektedir. Film sentezi sırasında mümkün olduğunca uygulaması kolay bir reçetenin oluşturulmasına özen gösterilmiş, üretim sırasında filme anti mikrobiyal özellik kazandırmak amacıyla birtakım modifikasyonlar gerçekleştirilmiştir. Film reçetelerinin modifikasyonunda hem filme antimikrobiyal özellik kazandırmak hem de filmin dayanımını arttırmak amacıyla sentez bileşenlerine tri sodyum fosfat ve nane ekstraktı eklenmiştir. Sentezlenen filmler ile elde edilen ilk sonuçlar, üretilen filmler ile kısa süreli tavuk parçalarının saklanabileceğini göstermiştir. Çalışma kapsamında gerçekleştirilen damlama kaybı testlerinde film ile sarılan tavuk parçaları 24, 48, 72 ve 168 saat süreyle buzdolabında bekletilmiştir. Elde edilen sonuçlar genel olarak nişasta eklenmesi ile filmlerin degradasyonunun hızlandığını göstermiştir. Nişasta film dayanımı için olumsuz etkiye sahiptir. Ancak Nişastadan bağımsız olarak 48 saat süre sonunda filmlerde çözünmeler meydana gelmiştir. Sonuçlar genel olarak değerlendirildiğinde sentezlenen filmlerin kısa süreli tavuk saklamada işe yaradığı ancak sentez reçetesinin özellikle degradasyonu yavaşlatacak şekilde modifiye edilmesi gerektiği anlaşılmıştır.

Anahtar Kelimeler: Biyobozunma, film, PVA, Nişasta

PRODUCTION AND CHARACTERIZATION OF BIODEGRADABLE FILMS

ABSTRACT

Biodegradable films have extensively been utilized in food preservation. The goal of food preservation is to maintain product freshness until expiration date. To achieve this goal, the ingredients of biodegradable films should be compatible with the food and the ingredients should not cause contamination during interaction. Besides biodegradability, the ingredients forming the film should both be adjustable and replaceable to enable the change of properties towards achieving anti-microbial activity. Hence studies related to film syntheses were focused on achieving anti-microbial activity.

The present study investigated synthesis of poli vinyl alcohol and starch containing biofilms. Synthesis procedure was established considering facile combination of the ingredients. PVA and starch as the main constituents was enriched with various ingredients to achieve anti-microbial activity.

Tri sodium phosphate and mint extract were added to synthesis procedure to maintain both anti-microbial activity and strength. Initial results obtained with films indicated that these films could have safely been utilized in preservation of chicken parts. Drip loss studies with chicken were conducted with samples refrigerated for 24, 48, 72 and 168 hours. Results indicated that film degradation had been accelerated in the presence of starch and hence starch has been identified to have negative effect on strength. Drip loss studies also confirmed that film formulations utilized in the studies had been stable for 48 hours and drip loss studies conducted for higher times resulted in degradation of the film. Consequently, film formulations maintained successful preservation of chicken parts provided that these were stored for short time intervals. Also, film formulations should be modified to increase the time interval.

Keywords: Biyodegradation, film, PVA, Starch

1. INTRODUCTION

The advance in technology expedites the lives of individuals. These reflected to all aspects of daily routine including nutrition. As a result, nutrition preferences evolved to convenience food. Convenience food, as the name suggests, is served momentarily. Food, once purchased and stored in the fridge should be able to retain its nutrition value without any loss for a specified time interval.

Hence the primary goal is maintaining the purchased food preserved for a specified time. Active packaging emerges as an effective method in achieving this goal. The method basically involves the design of modified active packages, the modification of which was intented to extend the shelf life. Modification of active packages mostly included addition of anti oxidants and ingredients with anti-microbal activity (Antholak et al. 2020).

Film formulations utilized in food preservation was composed of eco-friendly natural ingredients. The selection of renewable and biodegradable ingredients were frequently preferred to avoid carcinogenic effects of plastics. The accumulation of used plastics was also acknowledged among the reasons of environment pollution. Carbon sources such as proteins, polysaccharides and lipids are frequently recognized as the ingredients of biodegradable films (Erdohan et al. 2013).

Biodegradable films are being developed as substitutes of petroleum-derived materials. These, without sacrificing quality, should be able to enhance shelf life of the food and at the same time manufactured economically (Srinavasa et al. 2003).

The first and the most important stage in enhancing the shelf life of food is preventing pathogen development on food which could be achieved via gaining anti-microbial activity to the film material. The present study aimed to develop a biodegradable film recipe with anti-microbial activity. The recipe was designed to contribute to the decrease of environmental concerns emanated from plastic film utilization.

2. MATERIAL AND METHODS

2.1. Biodegradable film recipes

A total of 6 recipes were developed in the course of study. The recipes were listed in Table 1.

Table 1. Biodegradable film recipes

Recipe	Ingredient
1	Poly viny alcohol (PVA)
2	PVA+starch
3	PVA+ tri sodium phosphate (TSF)
4	PVA+starch+ TSF
5	PVA+ mint extract (ME)
6	PVA+starch+ ME

The procedures applied in the study were basically a combination of sequential addition of ingredients. The ingredients were altered based on the recipe; however, the amounts remained the same. The procedure were given below:

- 50ml deionized water and 4g of PVA were mixed at 50°C (10 minutes) via ultrasonic bath.
- The mixing of the ingredients continued in magnetic stirrer following the addition of 20 ml glycerol (applied in all recipes).
- Mixing of the ingredients remained for another 15 minutes and TSF/ME solution (Recipes 3,4,5 and 6) was added to the mixture. TSF/ME solution was prepared by adding 0.3g ingredient to 10ml deionized water.
- The resulting solution was mixed for another 15 minutes.
- 1g starch (Recipes 2,4,6) was added and the solution was mixed for 15 minutes.
- 20 ml of solution was poured to petri dish.

The addition of ingredient depended on the recipe. As an example recipe 1 contained only PVA and the procedure included mixing of PVA with water.

2.2. Characterization of films

The moisture content, solubility index and solubility were determined according to Gomaa et al. 2022. The color measurements were conducted based on Devlez 2022.

2.3. Performance studies

The synthesized films were intended to be used in preservation of chicken. Hence drip loss studies accompanied with dry matter measurements were conducted in the study. Drip loss measurements included the steps given below:

- Film samples were cut 4x4 ml in size, weighed (A) and placed inside petri dishes previously placed inside drying oven (105°C, 2h) and desiccator (Room temperature, 30 min).
- Chicken breast was cut, weighed (B) and placed inside the film. The pieces utilized in analyses were kept approximately at 1g.
- The film should wrap the chicken pieces entirely to prevent any interaction with air.
- Separate samples prepared accordingly were kept inside the refrigerator for 24, 48, 72 and 168 hours.
- Petri dishes were removed from the refrigerator, kept at room temperature for 3o minutes.

% Drip loss was calculated as: $\frac{(C-A)}{B-A}$*100 (Sarfraz et al. 2021)

The dry matter of chicken was calculated both at the beginning of drip loss analysis and ith chicken breasts collected at the end (Sarfraz et al. 2021).

3. RESULTS AND DISCUSSION

The effect of recipes' ingredients on film properties was illustrated in Fig. 1. The initial results indicated the effect of starch on solubiilty. The decrease of values via starch addition implied the decrease of hydroxyl groups emanating from PVA presence. In fact, starch addition decreased the ratio of PVA on total ingredient. Unfortunately, an approximate 5% decrease in solubility was not significant. The swelling index values was another downfall of the recipes with values ranging in the vicinity of 10%. Evaluation of results implied poor characteristics of films in the case of utilization of food with high water content.

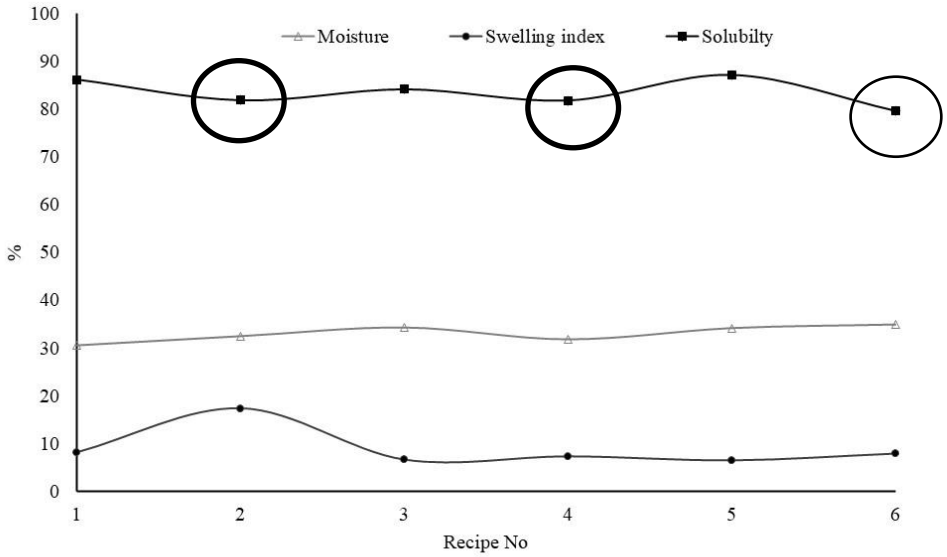

Fig. 1. Effect on ingredients on the properties of biodegradable films

The colour measurements were evaluated based on lightness values and results were interpreted to solely indicate the presence of the ingredients in recipes. The changes of lightness values validated successful addition of ingredients based on the recipe (Fig. 2).

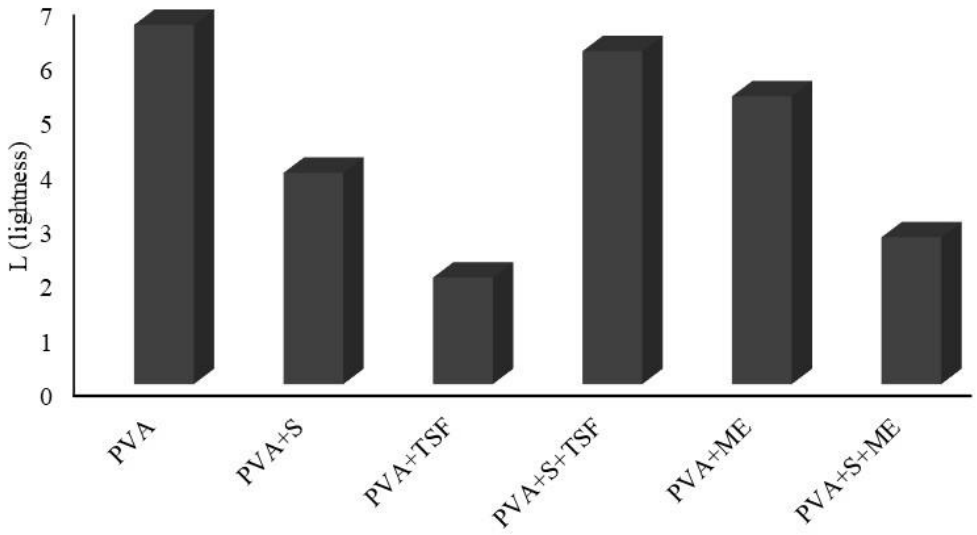

Fig. 2. The change of lightness values via ingredients in recipes

The poor performance of films estimated from characterization analyses was validated with drip loss values illustrated in Fig. 3. Results indicated a decrease of drip loss in recipe 2 prepared with starch addition. Drip loss was a measure of mass change of the film at the end of specified time and water release from chicken breast should in all case increase the values. However, the recipes 2, 4 and 6 indicated a decrease at the end of 48 hours. Starch was the common constituent of all samples and results implied dissolution of film ingredients probably due to starch existence.

On the other hand, results were still promising since drip losses of recipes 1, 3 and 5 increased at the end of 48 hours. Having said that, drip losses of these recipes decreased at the end of 72 hours. In other words, we have in our hands, biodegradable films suitable for short term preservation of chicken. The change of dry matter over time was somewhat more meaningful in explaining the performances of films, hence an increase in dry matter was out of question. Yet the increases observed in all recipes implied dissolution of film material even in short periods of time (Fig. 4).

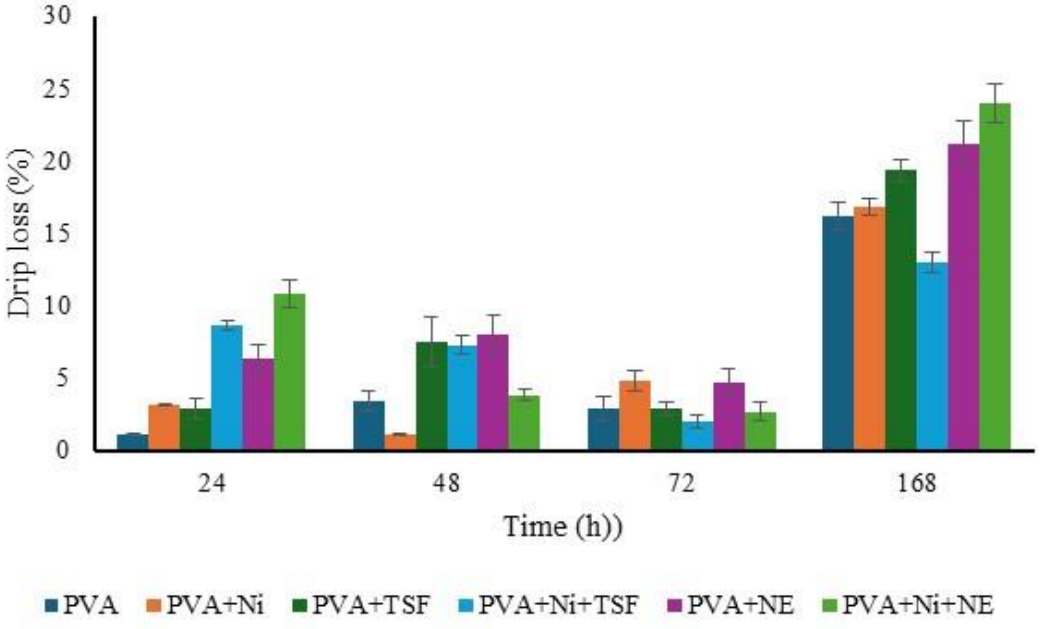

Fig. 3. Drip loss change with time

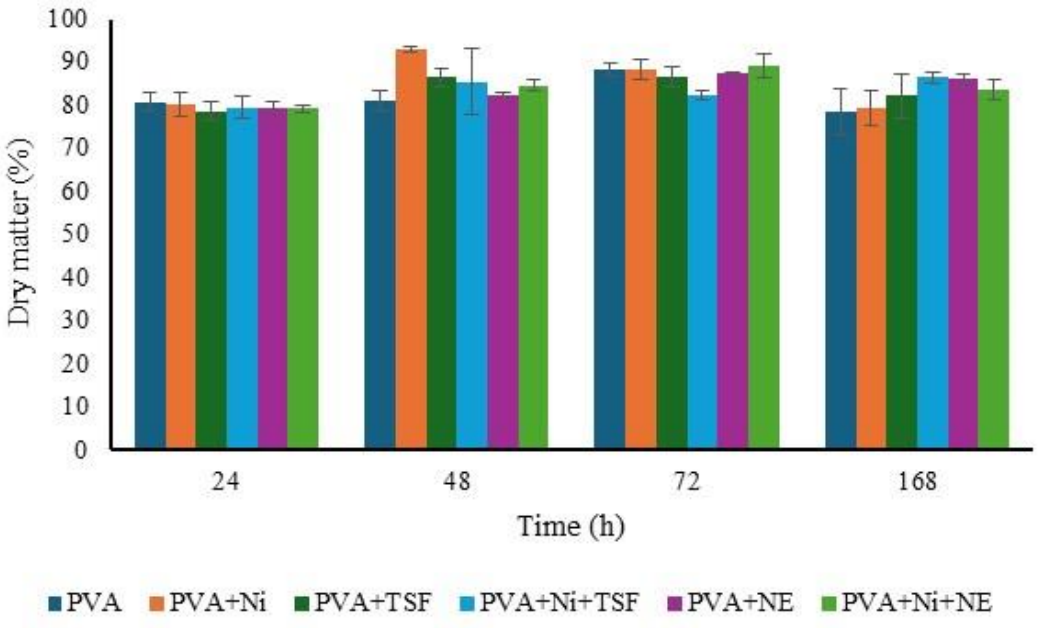

Fig. 4. Dry matter change with time

Results evaluated in accordance indicated the development of biodegradable film recipes promising for future applications. However, the first task for future studies was to improve the synthesis procedure and produce films durable for longer time periods. The dissolution was more evident in the presence of starch which implied poor interaction of PVA with starch.

Starch utilization is pre requisite for obtaining biodegradable films and therefore efforts will be concentrated on developing the interaction of starch and PVA rather than elimination of starch from recipe formulation.

REFERENCES

Antolak, H., Czyżewska, A., Kręgiel, D. (2016). Anti-adhesion activity of mint (Mentha piperita L.) leaves extract against beverage spoilage bacteria Asaia spp. Biotechnology and Food Science, 80(2), 119-127.

Erdohan, Z. Ö., Çam, B., Turhan, K. N. (2013). Characterization of antimicrobial polylactic acid based films. Journal of Food Engineering, 119(2), 308-315.

Devlez, E. (2022). *Ultraviyole A ve B ışık uygulamasının hasat sonrası marullarda (Lactuca sativa) bazı kalite değerlerine etkisi* (Master's thesis, Bilecik Şeyh Edebali Üniversitesi, Fen Bilimleri Enstitüsü).

Gomaa, M. M., Fadly, E. E., Salama, M. A., Abdin, M. (2022). Production of bio-composite films from gum Arabic and Galangal extract to prolong the shelf life of Agaricus bisporus. Journal of Polymers and the Environment 30(11), 4787-4799.

Srinivasa, P. C., Ramesh, M. N., Kumar, K. R., Tharanathan, R. N. (2003). Properties and sorption studies of chitosan–polyvinyl alcohol blend films. Carbohydrate polymers, 53(4), 431-438.