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El-Eshar (*Calotropis Procrea*)Fibers Combined With Gelatin as Edible Coating for Strawberries

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Abstract

The rheological properties of prepared viscous edible solution from *Calotropis Procera* (El-Eshar) were studied to investigate the flow behavior of blends which is important factor for food coating materials. Different rheological parameters (shear stress, shear rate, and viscosity) were studied at different concentrations of El-Eshar (0.25%, 0.5% and 1%). The samples were tested using Brookfield engineering labs DV-III Ultra Rheometer. The effect of El-Eshar/gelatin as edible coating on physical properties (weight loss and respiration rate) was studied. The results observed that all samples exhibited Non- Newtonian shear thinning behavior. Edible coating using different blends of El-Eshar and gelatin affects weight loss and respiration rate of strawberries in comparison with control sample (uncoated sample). The results indicated that weight loss and respiration rate decreased by using edible coating.

Keywords: *Author Guide, Article, Camera-Ready Format, Paper Specifications, Paper Submission.*

1. Introduction

With an ever increasing demand of consumers for high level of quality for food products in addition to raised environmentally concerns regarding the adverse effect of plastic packaging, food industry drive to develop and implement of new type of the edible films [1]. Edible films comprised of various edible substances such as polysaccharides, lipids proteins, or their combinations which are classified based on used composition [2]. Approaching edible films as food packaging could have a number of advantages, including biocompatibility and environmental friendliness, extended shelf life [3], cost-effectiveness, and strong barrier properties to gasses and carriers of other food additives such as vitamins, antimicrobial, and antioxidant agents [4,5].

Controlling microorganisms by integrating antimicrobial agents into packaging films has gotten a lot of publicity as a way to create safer goods with longer shelf lives. Previous studies [6] have shown the ability of extracted essential oils from plants to slow down the spoilage process. Plants are reported to have antimicrobial, anticancer, anti-inflammatory, antidiabetic, hemolytic, antioxidant, larvicidal properties etc [7].

Calotropis procera, a member of the Asclepiadaceae family, is a 3 to 5 m tall woody, broadleaf, evergreen coarse shrub occurring in the tropics. It can be found in arid to semiarid regions of the Caribbean, Central America, South America, Africa, India, and Israel, where it grows primarily on plains and in uplands. *C. procera* has been used in traditional folk medicine for decades because of its medicinal properties. Meanwhile, chemical extracts from C. procera have been shown to have ascaricidal, schizonticidal, antibacterial, anthelmintic, insecticidal, anti-inflammatory, antidiarrheal, larvicidal, cytotoxic and analgesic effects [8].

Gelatin is another raw material used in this research. Gelatin is a typical water-soluble functional protein that has a lot of interest and value because it can shape transparent gels under some conditions. Gelatin is a structure of variable physical properties that is obtained by heat dissolution at alkaline or acidic pH and partial hydrolysis of collagen in animal skins, bones, and tendons. Gelatin is notable for its unique gel-forming ability, which makes it a valuable material for investigating the fundamental functional properties in colloid studies, despite some Solubility is determined by the method of manufacture, in most cases, gelatin may be dispersed in a concentrated acid. Such dispersions are suitable for coating or extrusion into a precipitating bath, and they are chemically stable for 10–15 days [9]. In gelatin solutions, viscoelastic flow and streaming birefringence can be observed. Gycerol is one of the raw materials used, it is also known as glycerin) and is a polyol (1,2,3-propanetriol) that is found naturally in the structure of triglycerides (fatty acid esters of this alcohol). This substance has a large number of uses (over 2000) in various fields such as cosmetics, pharmaceuticals, and food, where it is primarily used as a humectant, thickener, lubricant, sweetener, or anti-freezer, among other things. Glycerol is completely soluble in water and alcoholIt is soluble in ether, ethyl acetate, and dioxane but not in hydrocarbons. Because of its three hydroxyl groups, glycerol has useful solvent properties similar to water and simple aliphatic alcohols [10].

The aim of the project is to study the rheological properties of the prepared edible coating using different concentrations of *Calotropis procera* incorporated with gelatin (0.25%, 0.5% and 1%). Also study the effect of edible coating on weight loss and respiration rate of strawberries.

1. Methods

2.1 Identification of El-Eshar *(Calotropis procera)*

Calotropis procera plant belongs to the Asclepiadaceae family. It is prescribed to treat bronchitis, asthma, cough, infections, cancer, ascites, intestinal worms, cutaneous diseases, eczema, leprosy and also aid to stimulate the immune system. The leaves of C. procera were investigated for their phytochemical and anti-microbial activity [11].A voucher specimen of the collected plant is released in the herbarium of either King Saud University (code:KSU-001003016) and National Research Center (code:CP-NRC-XC 091178), [12]

C. procera plant was collected from the natural population growing in Ismailia desert road, Egypt. GC/MS spectra of the *C. Procera* showed presence of 15 components, the results are summarized in Table 1.

Table 1: Some physical properties of Calotropis Procera fiber

Peak#	R. Time	Area	Area%	Name
1	10.743	274843	7.97	1-Tridecene
2	13.238	562444	16.32	3-Eicossene
3	14.298	95392	2.77	8-Pentadecanone
4	15.596	447262	12.98	3E-3-Icosene
5	16.548	147087	4.27	(1-Proyloctyl) Cyclohexane
6	17.683	234750	6.81	1-Heptadecene
7	18.717	199263	5.8	1-Nonadecene
8	19.531	205357	5.96	Sulfurous acid
9	20.414	207889	6.03	Di-n-octyl phthalate
10	20.779	217926	6.32	1-Tricosene
11	21.216	202490	5.87	Tetratriacontane
12	21.99	312639	9.07	n- Tetratriacontane
13	22.776	124989	3.63	2-ethylexyl iso-hexyl ester
14	23.644	169722	4.92	2,6,10,15-Tetramethyleptadecane
15	24.624	44959	1.3	Docosane
		3447012	100	

The chemical properties of the majors GC/ MS obtained compounds were represented in Table 2, [7].

Table 2. The chemical properties of four major compounds of the chromatographic fraction of *C. procera* using GC-MS analysis

LibraryL/ID	Retention Time	Mol. Formula	Mol. Weight
1-Tridecene	10.743	$C_{13}H_{26}$	182
3-Eicosene	13.238	$C_{20}H_{40}$	280
(3E)-3-Icosene	15.596	$C_{20}H_{40}$	280
n-tetratriconate	21.990	$C_{34}H_{70}$	478

2.2 Preparation of Edible Film

Firstly, seeds of *Calotropis Procera* fiber are removed (purification) and then fiber is delivered to the cutting step to finally form very fine powder as shown in figure 1.

Gelatin is mixed with water with heating at constant temperature 60℃ (250 ml water, 7.5 g gelatin) using a thermostatic water bath. After total dissolution *Calotropis Procera* fiber powder is added in different concentrations (0.25%, 0.5% and 1%), and then temperature is increased until boiling point is reached.

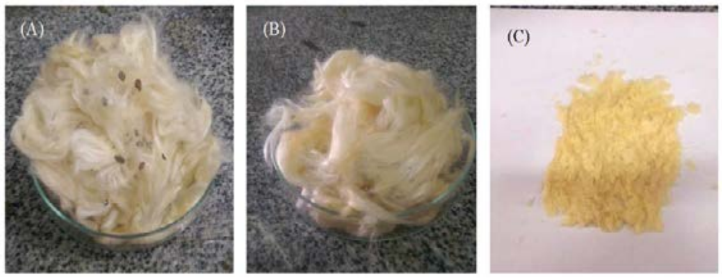

Fig.1. (A) Calotropis Procera fiber, (B) Removal of seed (C) very fine particles of Calotropis Procera fiber

High stirring is required in order to dissolve all the fiber in the gelatin-water solution. The mixture was stirred at 100°C and 400 rpm for 15 min till total dissolution then glycerol is added in 1% concentration to obtain homogenized edible viscous solutions. Then the viscous solution is used for coating fruits and vegetables. Viscous solution is delivered to casting and drying step [13]. The solution was poured into a petri dish and placed into a laboratory oven at 40°C for 24 hours to dry the samples, after drying the film was peeled off manually as shown in figure 2.

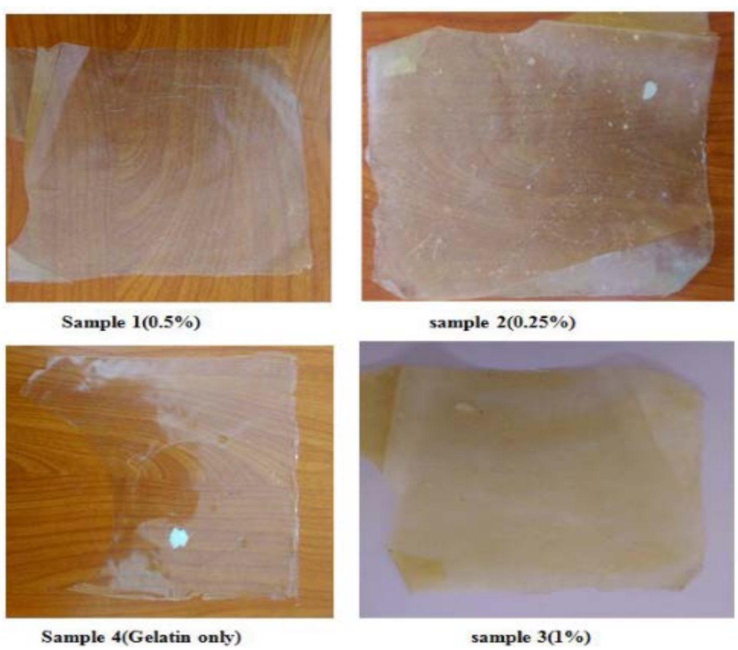

Fig. 2 Prepared edible films

2.3 Weight Loss

Weight loss was determined by individually cheese weighing with analytical balance at the beginning and during the storage period. The percentage of the relative weight loss (ΔW) was calculated based on the following equation (1).

$$\Delta W\% = \frac{I_{wo} - F_{wi}}{I_{wo}} \longrightarrow \quad (1)$$

2.4 Respiration Rate

Respiration rate of different strawberry samples was recorded in the headspace of the container using Witt oxybaby headspace gas analyser (O_2/CO_2). Concentration of CO_2 was measured by piercing the prop of gas analyser in container through the fixed lid.

2.5 Rheological Properties:

The rheological properties of prepared viscous edible solution from *Calotropis Procera* (El-Eshar) were studied to investigate the flow behavior of blends which is important factor for food coating materials. Different rheological parameters (shear stress, shear rate, and viscosity) were studied at different concentrations of El-Eshar (0.25%, 0.5% and 1%). The samples were tested using Brookfield engineering labs DV-III Ultra Rheometer. The blends were placed in a small sample adapter, the viscometer was operated between 10 – 100 rpm then shear stress, shear rate, and viscosity data were obtained directly.

3 Results And Discussion

3.1 Effect of Shear rate on Apparent viscosity and Shear stress of Edible Coating Blends

The relation between shear rate and apparent viscosity of the edible blend made from El-Eshar and gelatin were fitted well to the following power law equation:

$$\tau = k.\gamma^{n} \quad (2)$$

Or

$$\mu = k.\gamma^{n-1} \quad (3)$$

The results indicated that all samples exhibited non-Newtonian shear thinning behavior as viscosity decreased with increasing shear rate as shown in figures 3,4.

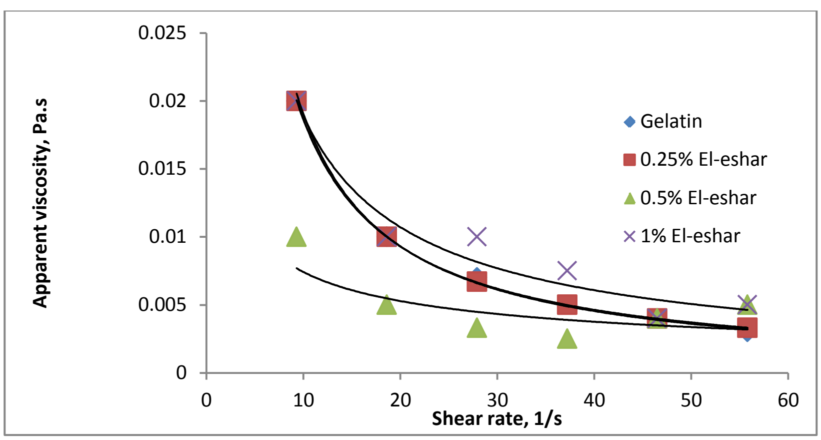

Fig. 3. Effect of shear rate on apparent viscosity of different edible coating blends

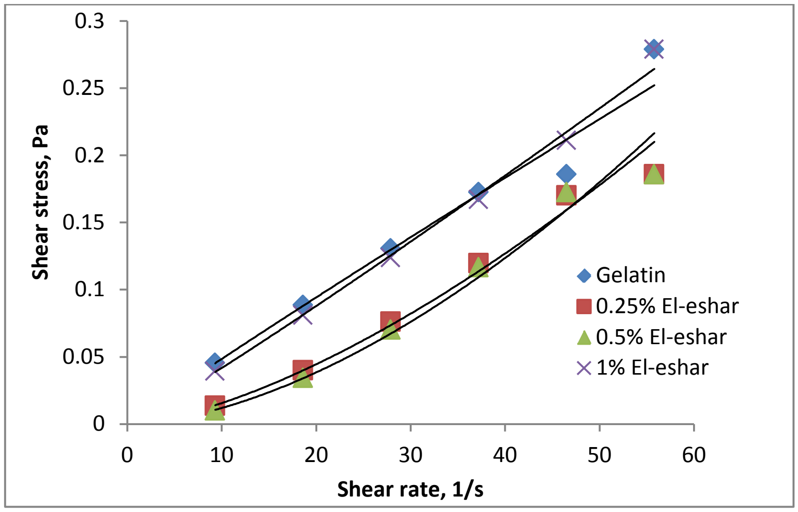

Fig. 4. Effect of shear rate on shear stress of different edible coating blends

The rheological behavior of these solutions follows the power law model. It was possible to fit the experimental data to that model so as to obtain the following equations:

For 0% C. Procera, Gelatin	$\tau = 0.2059\gamma^{0.067}$
For 0.25% C. Procera	$\tau = 0.1878\gamma^{0.097}$
For 0. 5% C. Procera	$\tau = 0.023\gamma^{1.051}$
For 1% C. Procera	$\tau = 0.0035\gamma^{1.0741}$

3.2 Weight Loss

Figure (5) shows the effect of gelatin /El-Eshar on weight loss of strawberry during storage at 4°C. The results indicated that weight loss decreased throughout storage period compared with control sample (without coating) which had the highest weight loss percentage (43.04%) this is due to that edible coating are selective barriers to O_2 and CO_2 modifying internal atmospheres and slowing down the respiration rate of fruit which in turn reduce weight loss [14] , also gelatin alone reduce weight loss but not as effective as the blend of gelatin and El-Eshar, whereas gelatin/Al-Esahr (1%) had the lowest percentage of weight loss, these results agreed with Mohamed, et al., 2018 [15] who stated that edible coating reduce weight loss percentage.

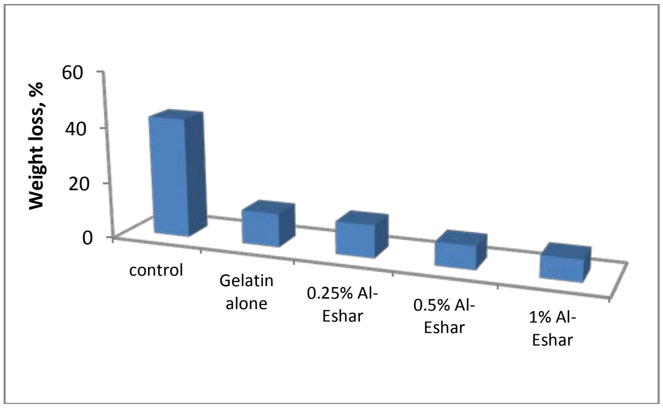

Fig. 5. Weight loss of strawberry

3.3 Respiration Rate

The rate of respiration is influenced by the storage environment's gaseous composition, relative humidity, and temperature. Reduced O_2 concentrations, as well as increased CO_2 concentrations, cause a reduction in the respiration rate of fruits and vegetables, up to a certain stage. [16]

Figure (6) depicts the effect of Al-Eshar/gelatin edible coating on strawberry respiration rate, the findings showed that edible coatings reduce strawberry respiration rates by decreasing permeability to water vapor and gas exchanges for fresh products. [17]

Coated strawberries emitted less CO2 than the control, which had a higher respiration rate (0.0743 cm3/g.h), indicating that a higher respiration rate was associated with an improvement in respiration rate. For 0.25 El-Eshar/gelatin, the lower respiration rate (0.032cm^3/g.h) was used.

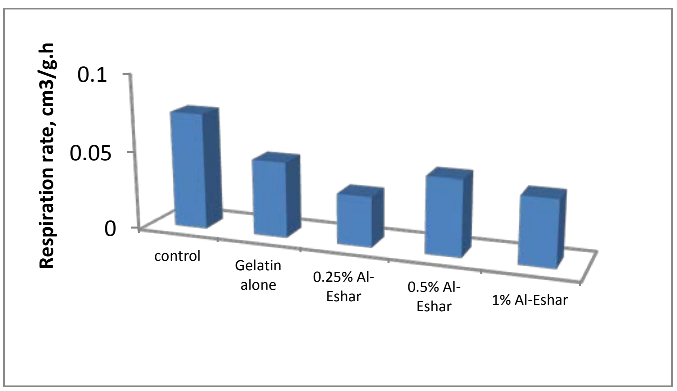

Fig.6. Respiration rate of strawberry

Conclusion

The effect of using El-Eshar fiber incorporated with gelatin as edible coating for strawberry fruit was studied. The rheological properties of different blends were studied and the results observed that all samples exhibited Non- Newtonian shear thinning behavior. Edible coating using different blends of El-Eshar and gelatin affects weight loss and respiration rate of strawberries in comparison with control sample (uncoated sample). The results indicated that weight loss and respiration rate decreased by using edible coating.

Abbreviations

I_{wo} is the initial strawberry weight

F_{wi} is the final strawberry weight at time, i

γ Shear rate (1/s)

τ Shear stress (Pa)

μ Viscosity (Pa. s)

n Flow behavior index

k Consistency index

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