Preparation of edible film of dextran produced by Leuoconostoc mesenteroides and studying its effect on the microbial and Quality properties of cryopreserved fish

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Abstract.

The current study aimed to isolate and identify Leuoconostoc mesenteroides bacteria and investigate its ability to produce dextran polymer and use it in the preparation of a bio-based, safe, and environmentally friendly film instead of traditional commercial films that are harmful to health and the environment, especially plastic. Furthermore, the film was enriched with oils extracted from basil leaves and fenugreek seeds. Its antimicrobial and antioxidant activity was evaluated, as well as its effect on the physicochemical and sensory properties of fish fillets preserved in a refrigerator at 5°C for 18 days. The fish packaging treatments included T1 (control) coated with polyethylene, T2 (dextran film only), (T3) dextran film with 5% fenugreek oil, and (T4) dextran film with 5% basil oil. The results showed that the basil extract had the highest inhibitory diameter (21 mm) against Staph aureus. The free radical scavenging capacity of fenugreek and basil extracts was 94.76µg/ml, and 91.34µg/ml for fenugreek and basil oils, respectively. As for the physicochemical and sensory properties of the fish coated with a dextran film enriched with vegetable oils, the unenriched one, and the control treatment, the results showed significant differences in the free fatty acid (FFA) and thiobarbituric acid (TBA) values after packaging and storage for all treatments between the control, enriched, and unenriched packaging treatments at a probability value less than 0.05. FFA values decreased for the coated treatments at a probability level of 0.05 on day 6, as the percentage of free fatty acids reached (1.470, 1.350, 1.210, 1.270) for treatments T1, T2, T3, T4, respectively, and a slight increase was observed on day 12, as it reached (1.980, 1.780, 1.320, 1.380) and continued to rise on day 18, and was (2.510, 2.180, 1.750, 1.520) for the treatments, respectively, As for the TBA values, they reached (0.023-0.964) and (0.102-0.927) mg malondialdehyde/kg meat for treatments T3 and T4, respectively, during the storage periods, compared to a significant increase compared to the control treatment, which reached (1.944-0.189) mg malondialdehyde/kg meat. As for the sensory evaluation, the results showed superiority in the sensory properties of the coated fish samples fortified with vegetable oils, with an increase in the storage period compared to spoilage in the control treatments. Therefore, we recommend using packaging materials from natural sources that are safe, healthy وsustainable, and environmentally friendly, as well as improving the economic efficiency of packaging materials. , and avoiding synthetic or petroleum-based packaging materials, especially plastic.

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Keywords. Edible film, Leuoconostoc mesenteroides, dextran, cryopreserved fish, microbial properties, chemical properties, sensory properties

.1 **Introduction**:

The process of packaging food materials is necessary to preserve food products and has developed and continues to develop to meet the requirements of the consumer and modern society [1]. Perishable and semi-perishable food products as fish are inherently vulnerable to environmental and biological contamination. Edible coatings and coatings help reduce contamination and improve the shelf life and nutritional properties of food products [2]. Advances in food packaging have garnered significant research attention, focusing on modern methods, particularly sustainable and environmentally friendly ones such as biopolymers produced by microorganisms, such as dextran, urea, xanthan gum, or chitosan [3 .[

Dextran is used in many food industries, as well as pharmaceuticals and a number of commercially important materials. It is one of the most widely used exocellular homopolysaccharides in food and medical applications. Its distinctive properties have made it a focus of attention for researchers in its production from microorganisms [4]. The properties of dextran, represented by its structural formula, degree of branching, molecular weight, and solubility in water, are the distinctive properties of the microorganism that produces it [5]. Microorganisms known to produce dextran include the bacterium Leuoconostoc mesenteroides [3]. They cannot withstand high temperatures of 55°C for 30 minutes, but their viscous cultures in sugar media can withstand a temperature of 85°C [6 .[

Fenugreek belongs to the legume family and has been used medicinally and nutritionally for more than 2,500 years. Its seeds contain 23–26% protein, 6–8% fat, and 45–50% dietary fiber, along with several active compounds such as saponins, trigonelline, diosgenin, and the highly viscous galactomannan [7]. Recent studies have demonstrated fenugreek's blood sugar- and cholesterol-lowering activity, its antimicrobial and anti-inflammatory effects, and its potent free radical scavenging capabilities [8 .[

Basil, a member of the Lamiaceae family, is known for its aromatic oils rich in linalool and methyleugenol, and for its nutritional content, which is rich in protein (11.4–22.5%), fiber (7.1–26.2%), fat (9.5–19.6%), and unsaturated fatty acids (such as linoleic and linolenic), in addition to essential minerals [9]. Its oils and seed mucus have demonstrated inhibitory activity against a wide spectrum of bacteria and fungi, as well as antioxidant activity that reduces lipid rancidity and enhances color fastness [10]. Based on the above, this study aims to produce a dextran polymer from Leuo. mesenteroides and its use in preparing edible, safe and healthy films, enhancing the value of these films with oils extracted from fenugreek and basil as antimicrobials and antioxidants, and studying the effect of these films on the quality properties of refrigerated fish.

.2 Material and Methods:

2.1 Isolation and identification of dextran-producing Leuoconostoc mesenteroides

Leuoconostoc mesenteroides was isolated from sauerkraut by withdrawing 1.0 ml of the pickle and culturing it in MRS medium. The identification was made by examining its cultural characteristics, which included colony shape, size, color, margins, and height, and its ability to produce dextrin through the formation of mucous colonies. The morphological properties of the colonies were evaluated on MRS medium. Its ability to produce dextran was investigated by examining the viscous growth characteristic when grown in MRS [11]. Microscopic examinations were performed to determine the shape and type of bacteria or their reaction to Gram stain [12], and biochemical tests included catalase enzyme test, sugar fermentation and growth at different temperatures, and growth at 3% and 5% sodium chloride concentrations. Identification was confirmed to the species level using the VITEK 2 Compact system.

Leuo. mesenteroides was isolated and identified from sauerkraut by withdrawing 1.0 ml of the sauerkraut and culturing it on solid MRS medium. The plates were incubated at 37°C for 24 h. White; slimy colonies were selected and then re-cultured on liquid MRS supplemented with 10% sucrose to stimulate exopolysaccharide production (slimy production) and to ensure the purity of the isolate. MRS medium uses sodium acetate as a selective agent to inhibit the growth of all non-lactic acid bacteria (LAB), making it an ideal medium for the isolation and identification of Leuconostoc species [13]. The addition of sucrose to the liquid MRS medium as a catalyst for the production of the enzyme dextransucrase, leads to the formation of the dextran polymer, a feature that distinguishes this species from others [14]. The methodology of the work ensures that we obtain a pure and productive isolation of dextran.

2.2 Dextran production from Leuoconostoc mesenteroides isolate

- Bacterial inoculum preparation.
- The fermentation process was carried out by inoculating a beaker containing liquid MRS medium containing varying percentages of sucrose (10%) and inoculating 3 ml of Leu. mesenteroides cells/ml were identified by comparison with the standard McFarland solution by measuring absorbance at a wavelength of 600 nm. The cells were then incubated for 48 hours in an incubator at 28°C and pH 7.2 [15.[
- Separation and Purification of Dextran: The produced dextran was isolated and purified by adding cold pure ethanol (frozen for 48 hours), shaking gently, and leaving it to settle at the bottom of the flask. The dextran was then separated by centrifugation at 6,000 rpm for 10 minutes, then filtered through filter paper and left in the oven to dry [16]. The dry weight of dextran was calculated using the following equation:

Weight of dextran (g) = Weight of dextran with filter paper - Weight of filter paper

2.3Bacteria used in the study:

The bacterial species used in the study, including Staphylococcus aureus, Escherichia coli, and Salmonella spp, were obtained from the Department of Food Sciences, College of Agriculture, Tikrit University.

2.4 Extraction of essential oil

Basil and fenugreek plants were collected from local markets in Tikrit city. They were placed in plastic bags and identified based on the taxonomic keys: Flora Iraq and Flora Turkey [17]. Fenugreek and basil oils were extracted using hydrodistillation using a Clevenger apparatus (LG-6656-100, Wilmad, Ottaw, ON, Canada). Fifty grams of fenugreek seeds were chopped into very small pieces and added to 500 ml of distilled water in a 1-liter volumetric flask. The mixture was boiled at 100°C for 12–14 hours. After distillation, the oil was separated from the water using a separating funnel. The oil was then stored in small, opaque, tightly sealed glass bottles until ready to use [18.[

2.5Estimating the inhibitory activity of extracts on the growth of microorganisms

The activity of essential oils was estimated using the well diffusion method, as stated in Abre [19]. Different concentrations of each extract (0.1, 0.3, and 0.5 mg) were used against a number of selected bacteria. One hundred (0.1) microliters of suspension of the bacterial species used in the study, namely Staphylococcus aureus, Escherichia coli, and Salmonella spp, were taken and spread with cotton soap. 6 mm diameter holes were then made on the surface of the solid Mueller-Hinton medium. The plates were then incubated at (37) °C for 24 hours. The diameter of the inhibitory halo was then measured for each extract against each type of tested bacteria.

2.6Estimating the antioxidant activity of extracts

The DPPH method was used to measure oxidative capacity. The DPPH radical was used. 28 μL of the sample was mixed with 28 μL of DPPH ethyl alcohol. 944 μL of ethyl alcohol was then added to the mixture and left in the dark for 10 minutes. The reading was taken using a spectrophotometer at a wavelength of 515 nm [20.[

The following equation was applied: where {A0-A1 (/A0)} = 100

A0: represents the control (blank), which was prepared by mixing 28 μL of DPPH ethyl alcohol with 972 μL of ethyl alcohol .

Al: represents the sample reading in the spectrophotometer.

2.7Preparation of a Dextran film Supported with Vegetable Oils

The method of Azimzadeh and Jahadi [21] was followed with some modifications. The membrane was prepared after mechanical and barrier tests. The optimal concentration of dextran was selected, at 8%, with a small amount of water as the base material for the prepared coating. Glycerol was added as a colorant at a concentration of 5% by weight for the dextran under study, and at a concentration of 500 mg for the extract, based on the inhibitory activity of the extract against the tested bacterial species. The solution was mixed with distilled water to 100 ml. The solution was then homogenized at a speed of (5000) for one minute, and then mixed with a hot magnetic stirrer for one hour at a temperature of 70 °C. The plant extracts were then added, and the solution was allowed to cool. Then pour the resulting solution into glass Petri dishes or glass molds with a length of 22 cm, a width of 5 cm, and a thickness of 4 mm according to the required tests, and pour 7 and 12 grams of the solution into the glass dishes, respectively, according to preliminary experiments conducted to obtain the appropriate thickness. After the pouring process, move the mold very gently to the right and left to obtain a flat surface and to ensure its proper distribution throughout the mold. Then leave it to dry at room temperature for 24-48 hours. After that, remove the cover from the mold and place it in polyethylene bags and store it in the refrigerator at 24 degrees Celsius until tests are conducted on it.

2.8Dextran Film Coating of Fish Fillets:

Cyprinus carpio fish were purchased from local markets in Iraq. They were slaughtered, cleaned, and the internal organs and unwanted parts were removed. They were washed with distilled water, and then cut into fillets of similar dimensions and weights. The samples were divided into four treatments according to the composition of the prepared film, with two replicates for each of the subsequent tests. The fish fillets were coated using a surface pressure coating method (size press coating) to take the shape of the packaged food [22]. The treatments were as follows:

- Control treatment: 150 g of fish fillets were packaged in polyethylene.
- The second treatment involved wrapping 150 grams of fish fillets in a dextran film only.

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- The third treatment involved wrapping 150 grams of fish fillets in a dextran film enriched with 5% fenugreek.

- The third treatment involved wrapping 150 grams of fish fillets in a dextran film enriched with 5% alcoholic basil extract. They were refrigerated at 4°C for 18 days.

2.9Determination of Free Fatty Acids (FFA(

The percentage of free fatty acids (FFA) was determined according to the A.O.A.C. [23] by mixing 0.5 g of fish fillets with a mixture of diethyl ether 50 and ethanol 50 with drops of phenophthalein indicator. The mixture was then graded with 0.1 N sodium hydroxide base, stirring until a pink color appeared and remained for 10 seconds. The volume of base consumed was then calculated, and the percentage of FFA was calculated based on stearic acid, as shown in the following equation:

- NA * 100 x 28.4 x N g

- NA: Number of milliliters of sodium hydroxide consumed in the grade

- N: NaOH (0.1(

- Weight of sample Equivalent weight of stearic acid: 28.4

- × 28.4 × 100n

2.10Thiobarbituric acid (TBA) estimation

The method of Al-Azami [24] was used to estimate the thiobarbituric acid (TBA) value. This is summarized as follows: 5 g of the sample was mashed with 25 ml of a 20% trichloroacetic acid (TCA) solution dissolved in 2 M phosphoric acid for 2 minutes. The mixture was then transferred to a 50 ml volumetric flask, the volume was filled to the mark with distilled water, and the mixture was shaken. 25 ml of the solution was withdrawn and centrifuged at 3000 rpm for 30 minutes. The mixture was then filtered through 1.What.NO filter paper, and 5 ml of the filtrate was taken into a test tube. 5 ml of TBA reagent solution was added to it. (0.005) dissolved in water. The blank solution was prepared by mixing 5 ml of distilled water with 5 ml of TBA reagent solution. The contents of the test tubes were mixed well, sealed, and stored in a dark place for 16 hours at room temperature. The absorbance (A) of the obtained color was measured at a wavelength of (530) nm using a spectrophotometer. The TBA value was determined by multiplying the absorbance value by a factor of 5.2. The TBA value was expressed on the basis of mg of malondialdehyde (MDA)/kg of meat according to the following equation: - 5.2 x 530 mg MDA/kg of meat

2.11Sensory Evaluation of Fish Fillet Samples:

The sensory properties of the different treatments in the experiment were evaluated by a number of experienced evaluators after cooking according to the evaluation form by [25] with some modifications to suit the study.

2.12Statistical Analysis:

The results were statistically analyzed using the statistical program (Minitab Ver. 17) according to the ANOVA test, and the arithmetic means were compared according to Duncan's Multiple Range test at a probability level of 0.05.

.3 Results and discussion :

3.1 The Isolation and identification of dextran-producing bacterium Leuoconostoc mesenteroides

The genus and species were determined based on a combination of culture, microscopic, and biochemical tests, as described in (Table 1). The results of the cultural and microscopic properties of the isolate on MRS medium showed small white or transparent, sticky colonies with complete or semi-regular edges. Its microscopic properties were round, cocci, small, transparent cells in the form of short chains or pairs, positive for Gram stain. As for the biochemical tests, it was negative for catalase and was able to grow at temperatures of 10, 20, and 37 degrees Celsius, but was unable to grow at 40 and 45 degrees Celsius. It was also able to grow at salt concentrations of 3% and 6%, and was a producer of dextran, as indicated by the production of a sticky substance, which initially reflects its ability to produce dextran. The results also showed that the isolate ferments the following sugars: glucose, menthol, sucrose, lactose, and trehalose. These results are consistent with what has been reported in [26] based on the approved taxonomic keys.

Table1. Isolation and identification of Leuoconostoc mesenteroides bacteria

Teats			Growth in degrees Different thermals					Growth concentrations different salts		Fermentation of Carbohydrate					
Type of bacteria	Gram Stain	Catalase	5	10	28	37	45	3	6	Glucose	Manitol	Trialulose	Lactose	Fructose	Sucrose
Leuo. mesenteroides	+	-	-	+	+	+	-	+	+	+	+	+	+	+	+

Researchers Ghazi et al. [27] have indicated that the catalase test and gas production from glucose fermentation are used as taxonomic criteria to distinguish the genus Leuconostoc from other lactic acid bacteria genera. Its ability to produce dextran was also investigated by examining the viscous growth property when grown in MRS [11] the methodology ensured that we obtained a pure, dextran-producing isolate.

Furthermore, the isolate underwent automated confirmatory species identification using the VITEK 2 Compact. A bacterial suspension of the pure, young, or active isolate (18–24 hours old) was prepared, titrated to 0.5 McFarland Standard, and loaded into the device's bioassay cassette. The system then monitored more than 40 biochemical reactions of the tested isolate by sensing color change and light luminescence every 15 minutes for up to 8 hours. The resulting pattern was then compared to databases stored in the device's system. The VITEK 2 report showed a 99.9% match with Leuconostoc mesenteroides, with a high confidence level, which supports confirmatory species identification of the isolate using conventional manual testing

.

Figure1. *Leu. mesenteroides* sticky colonies on 10% sucrose MRS.

Figure2. *Leuc. mesenteroides* colonies on MRS

Mucoid/Ropiness-producing isolates were selected. As previously mentioned, mucoid/viscosity is an accurate indicator of the presence and activity of the enzyme dextransucrase. This characteristic is used to produce dextran as an exopolymer by dextransucrase in the presence of 10% sucrose in MRS medium. The yield of dextran was determined gravimetrically by separating dextran by precipitation by adding cold ethyl alcohol to the production medium and leaving it to freeze for 48 hours .

These results are consistent with what Lule et al. [20] indicated that the peak production of dextran was achieved by adding 10% sucrose to the medium. They also agreed with Sawrat et al. [28] who observed a decrease in dextran production when adding sucrose at concentrations higher than 15%, which reflects the phenomenon of what is called substrate inhibition, as crowding or high sucrose at the enzyme site hinders the effective reaction and reduces the production of external polymers, i.e., inhibition of the dextransucrase enzyme occurs. These results are consistent with Aman et al., reported. [26.[

The results of the inhibitory activity test of basil and fenugreek extracts, as presented in Table (2), show that basil extract outperforms fenugreek at all concentrations against various bacterial species.

Table2. Inhibitory activity of basil and fenugreek oils at concentrations of 1%, 3%, and 5% against E. coli, S. aureus, and Salmonella spp.

basil oils			
Salmonella spp	***S. aureus***	***E. coli***	**the focus**
mm 7	**mm 10**	**mm 8**	**1%**
mm 10	**mm 14**	**mm 12**	**3%**
mm 13	**mm 18**	**mm 16**	**5%**
fenugreek oils			
Salmonella spp	***S. aureus***	***E. coli***	**the focus**
mm 6	**mm 8**	**mm 6**	**1%**
mm 8	**mm 11**	**mm 9**	**3%**
mm 10	**mm 14**	**mm 12**	**5%**

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The highest inhibitory diameter was 18 mm at 5% concentration for basil extract against S. aureus, compared to 14 mm for fenugreek, reflecting greater antimicrobial activity associated with the abundance of phenolic compounds capable of penetrating the bacterial cell wall. This regular increase reflects a direct relationship between the concentration of the extract and the strength of its antimicrobial effect, which is consistent with the results of Alaobady and Thalj, [29] on the importance of increasing the concentration to improve the inhibitory effectiveness.

A DPPH test was conducted to evaluate the effectiveness of the essential oils. The IC_{50} value for the extract was 94.76 µg/ml, and for the oil, 91.34 µg/ml, as shown in Table (3.(

Table3. Shows the IC_{50} concentration values (µg/ml) for the two essential oils in the DPPH test to estimate antioxidant activity

essential oils	IC_{50} (µg/ml)
basil oils	94.76
fenugreek oils	91.34

The extract's ability to remove free radicals was found to be (91.34 µg/ml) (94.76 µg/ml) for fenugreek and basil oils, respectively. This confirms the role of the extracted oils as antioxidants, which is due to the presence of polyphenols, flavonoids, and coumarins, which delay rancidity reactions and preserve sensory properties [30]. Therefore, it is preferable to use extracted oils to enhance the resistance of fortified biofilms to lipid oxidation during chilled fish storage, as it reduces the deposition of harmful oxidative compounds at a faster rate [31.[

The results of FFA showed significant differences between the coated, fortified, and unfortified treatments (p value > 0.05) throughout the storage periods for all treatments at time zero (Table 4). A slight increase was observed on the sixth and twelfth days, and it continued to rise on the eighteenth day for all transactions. The results also showed that the treatment of the coating fortified with fenugreek extract T3 had lower values of free fatty acids (FFA) throughout the storage periods compared to the rest of the treatments, as it maintained a level of (1.20-1.75) compared to (1.46-2.51) for the control treatment T1. The elevated FFA levels were relatively lower in the oil-coated and enriched fish treatments compared to the uncoated and unenriched control treatments. This is attributed to the active compounds in the added oils, which act as antioxidants that inhibit the activity of lipolytic enzymes, thereby reducing FFA levels [23 .[

The reason for the increased FFA to lipase activity ratio is due to lipolytic bacteria, which break down the fats in fish fillets during refrigerated storage. This is due to the mechanical properties of the coatings, as they block oxygen from the fish fillets and thus reduce the development of oxidation, in addition to the presence of active ingredients in the oils that support the coating, which work to increase the ability of the membranes to inhibit the role of free radicals. [3.[

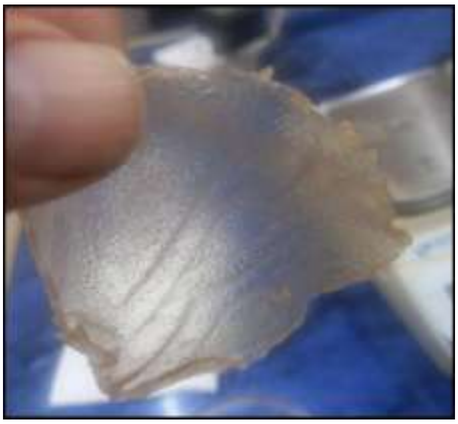 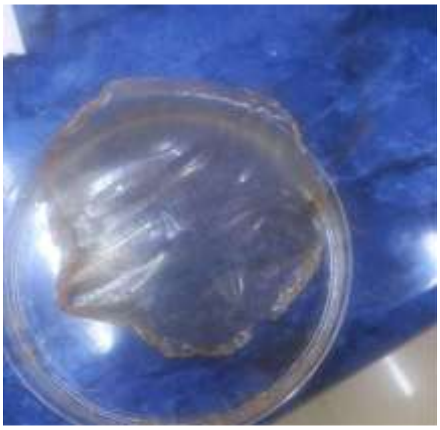

Figure3. The film of dextran

Table4. FFA values for meat slices for different treatments across refrigeration periods

Packaging transactions	Storage period (day)				
	Zero	6	12	18	Average transaction
T1	**1.460 def**	**1.470 def**	**1.980 bc**	**2.510 a**	**1.855 a**
T2	**1.340 ef**	**1.350 ef**	**1.780 c**	**2.180 b**	**1.663 a**
T3	**1,200 f**	**1.210 f**	**1.320 ef**	**1.750 CD**	**1.370 b**
T4	**1.260 f**	**1.270 f**	**1.380 ef**	**1.520 de**	**1.358 b**
Average duration	**1.315 c**	**1.325 c**	**1.615 b**	**1.990 a**	

Similar letters indicate no significant difference between them T1 = control sample, T2 = dextran coating only, T3 = dextran coating enriched with 5% fenugreek oil, T4 = dextran coating enriched with 5% basil oil .

Thiobarbituric acid (TBA) is one of the most important fish tests during refrigerated storage. It is an indicator of lipid oxidation and the decomposition of peroxides into aldehydes and ketones, which cause unpleasant odors in fish. Table (5) shows the TBA values for the packaged fish meat treatments and the unpackaged control treatment throughout the refrigerated storage period. The results of the statistical analysis, at a probability level of (P>0.05), showed significant differences in the TBA values after packaging and storage and before refrigerated storage for all treatments. A significant decrease in the TBA value was observed for the fortified packaged fish fillets compared to a significant increase in TBA values in the control treatment. The plant extracts provide additional protection by preventing the formation of methylenediamine (MDA), which leads to curbing and inhibiting the role of free radicals that cause lipid oxidation in preserved fish. The combined

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data confirm that the supported dextran films performed better during cryopreservation after the twelfth day, as a slight increase in TBA values was observed. This is due to the effective protection against lipid oxidation caused by polyphenols, flavonoids, and coumarins, which delays rancidity and preserves sensory qualities [32]. The permissible limit for TBA is 2 mg malondialdehyde/kg of meat [29.[

Table5. TBA values in fish fillets with different packaging treatments over refrigeration periods

	Storage period (day)				
Packaging transactions	**Zero**	**6**	**12**	**18**	**Average transaction**
T1	**0.189 d**	**0.191 d**	**0.985 bc**	**1.944 a**	**0.827 a**
T2	**0.083 ef**	**0.085 ef**	**0.614 c**	**1.209 b**	**0.498 b**
T3	**0.023 f**	**0.025 f**	**0.483 cd**	**0.964 bc**	**0.374 c**
T4	**0.102 de**	**0.104 de**	**0.646 c**	**0.927 cd**	**0.295 d**
Average duration	**0.099 c**	**0.101 c**	**0.682 b**	**1.111 a**	

Similar letters indicate no significant difference between them T1 = control sample, T2 = dextran coating only, T3 = dextran coating enriched with 5% fenugreek oil, T4 = dextran coating enriched

The sensory properties of the different treatments in the experiment were evaluated after cooking by 30 experienced evaluators with an average age of (28-55) years according to the evaluation form by [33.[

Table (6) shows the sensory properties of the treatments of fish fillets coated with reinforced and unsupported dexran films and the unsupported control treatment. The results of the statistical analysis showed a variation in the sensory properties of the coated and unsupported treatments and throughout the refrigerated storage periods. In the first week, all samples obtained similar scores before refrigerated storage, but the scores began to decrease with the increase of the storage period, and the decrease was slower in the coated and reinforced treatments compared to the unsupported film treatments and the control treatment. The barrier and mechanical properties, as well as the role of aromatic compounds such as phenols and flavonoids in vegetable oils added to the coatings, have enhanced the efficiency and performance of these films. This was confirmed by Zaiden and Al-Hadidy [34], who indicated that sensory attributes are a key factor in consumer acceptance of a food product. Therefore, paying attention to the sensory properties of reinforced biofilms is crucial when considering industrial applications.

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Table6. Sensory test results (0–18 days) for coated and uncoated Caribbean fish

Storage period (day)								
Packaging transactions	**Storage period**	**The taste**	**the color**	**smell**	**Consistency**	**General Admission**	**Final grade**	**Final grade average**
T1	**0**	**5**	**5**	**4**	**5**	**5**	**24 a**	**19.8c**
	6	**2**	**3**	**3**	**3**	**3**	**14**	
	12	**1**	**1**	**1**	**1**	**1**	**5**	
	18	**0**	**0**	**0**	**0**	**0**	**0**	
T2	**0**	**5**	**5**	**3**	**4**	**5**	**22 b**	**24.5 b**
	6	**3**	**4**	**3**	**3**	**4**	**17**	
	12	**2**	**4**	**3**	**3**	**3**	**16**	
	18	**1**	**2**	**1**	**2**	**2**	**8**	
T3	**0**	**5**	**5**	**5**	**5**	**5**	**25 c**	**29.5a**
	6	**5**	**5**	**5**	**5**	**5**	**25**	
	12	**4**	**4**	**4**	**4**	**4**	**20**	
	18	**3**	**3**	**2**	**2**	**2**	**12**	
T4	**0**	**5**	**5**	**5**	**5**	**5**	**25 c**	**29.5a**
	6	**5**	**5**	**5**	**5**	**5**	**25**	
	12	**5**	**4**	**4**	**4**	**4**	**21**	
	18	**2**	**3**	**2**	**3**	**2**	**12**	

Similar letters indicate no significant difference between them T1 = control sample, T2 = dextran coating only, T3 = dextran coating enriched with 5% fenugreek oil, T4 = dextran coating enriched with 5% basil oil.

.4 Conclusion :

The results of this study indicate that Leuo. mesenteroides can produce dextran and that it can be used to prepare edible, healthy, and environmentally friendly films. Enriching the film with oils extracted from fenugreek and basil gives it multifunctional properties. The active coating provides protection against microbial spoilage and oxidation, delaying rancidity, preserving physicochemical and sensory properties, and extending shelf life,Therefore, we recommend using packaging materials from natural sources that are safe, healthy وsustainable, and environmentally friendly, as well as improving the economic efficiency of packaging materials. , and avoiding synthetic or petroleum-based packaging materials, especially plastic.

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