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Development of Antioxidant Activity of Potato Starch Edible Films Incorporating with Rosemary *Rosmarinus officinalis* L. Oil and Using it in Packaging Beef Pattis

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Abstract: The purpose of this study is to investigate the antioxidant activity of edible films prepared from starch extracted from potatoes and corporate with essential oil extracted from rosemary leaves at 2,4 and 6% concentration and used in the packaging of beef patties stored at 4-6°C for 10 days. The results showed that antioxidant activity, reducing power and chelating of ferric ion increased with increasing oil concentration 70.1, 66.5, 73.7% respectively at 6% oil concentration. Thermogravimetric analysis and diagnosis of active groups of simple and oil corporate films were also performed. Changes in peroxide values of beef patties covered with simple starch films and films corporate with oil were followed. The results showed that the peroxide values were lower in the covered treatments compared to the control treatment that did not contain oil. The effect of adding rosemary oil increased prolonging the duration of storage of beef patties as long as storage.

Keywords: Edible film, Antioxidant, Starch, Thermogravimetric analysis, Essential oil.

Introduction

Adding antioxidants is a traditional way to control the deterioration of oxidation of meat and meat products. Industrial antioxidants have long been used effectively in a variety of foods for this purpose, however the overall rejection of industrial food additives by the consumer because of potential unsafe effects on health led to the search for natural alternatives to industrial antioxidants (Camo *et al.,* 2008). The utilization of varied herbs and spices and their extracts as natural antioxidants in many types of meat and meat product is effective in controlling oxidative damage and prevent the growth of bacteria and corruption and thus prolong their shelf life (Shan *et al.,* 2009). Research in this field focuses on the use of biodegradable packaging materials due to the negative environmental impact of plastic represented by edible films and coatings, which are good carriers for many food additives including antioxidants to control the changes caused by the oxidation process in food products during storage and it is among the most important factors responsible for the loss of quality in meat products (Ponce *et al.,* 2008). The incorporation of natural antioxidants into edible films and coatings modifies their composition and improves their functions and applicability in food (Coskun *et al.,* 2014).

The use of industrial antioxidants in food has been avoided because of its possible hazardous effect. Instead, this used a wide range of natural antioxidants such as essential oils and plant extracts which were corporates with edible films to improve their biologically active properties (Kadri *et al.,* 2011). Essential oil is natural compounds extracted from plants that have antimicrobial and antioxidant properties, which were included in food processing as antioxidant activity (Pirouzifard *et al*., 2019). Among these oils is rosemary plant oil. Rosemary (*Rosmarinus officinalis* L.) is of considerable importance in terms of its great an important medicinal and aromatic value. This plant is an evergreen perennial shrub belonging to the Lamiaceae family. It is an evergreen perennial shrub belonging to the Lamiaceae family (Kadri *et al.,* 2011). Native to the Mediterranean region, rosemary is now cultivated around the world due to its use as a natural food preservative and flavouring agent. The secret behind the preservative and the therapeutic abilities due to its essential oil and extract. Rosemary oil whose anti-oxidant activity is due to the active compounds. The major constituents of monoterpenes were 1,8-cineole (35.32%), borneol (9.37%), camphor (8.97%), α-thujone (6.42%). However, the principal components of monoterpene hydrocarbons were α-pinene (7.90%) and camphene (3.35%) (Kadri *et al.,* 2011). The anti-oxidant activity of this oil due to the active compounds present in this oil, and adding it to animal meals delays the process of oxidation of fats in meat (Atares & Chiralt 2016). Packaging using edible films corporate with natural plant extracts has become a successful industrial application for controlling oxidative changes in natural meat products. Films and coatings corporate with natural antioxidants help enhance the sensory properties of food and improve the quality of food products by increasing storage duration (Li *et al.,* 2014). Starch can produce biodegradable films at low cost and on a large scale. Furthermore, starch-based materials may contribute to the utilization of non-renewable resources and the environmental impact caused by synthetic plastics (Perazzo *et al*., 2014). Pirouzifard *et al*. (2019) found that the potato starch composite film containing zedo gum and salvia essential oil showed antioxidant properties and suitable to be used in the food packaging industry.

The present study aimed to develop the antioxidant activity of starch films which are corporate with oil extracted from rosemary leaves and study of its storage capacity, thermal stability, estimation of effective groups, the use in packaging beef patties stored at 4-6° C for 10 days.

Materials & Methods

All the chemicals used in the research are analytical types. The materials used in the preparation of edible films were brought from the local market (potatoes, rosemary leaves). The leaves were cleaned of impurities and stored in a glass container until used.

Extracting starch from potatoes

Potato starch was extracted according to the method of Bente *et al.* (2006) taking 1 kg of well-washed potatoes, removing its outer shells, then cutting into small pieces and mixing with 1 litre of water in a blender. The mixture was filtering through a piece of two layers of gauze cloth. The granules were held with water several times and centrifuged at a speed of 2000 rpm for 10 minutes. Then purified starch granules were dried at laboratory temperature for 24 hours and stored in plastic containers until used.

Preparation of the film-forming solution

The method was described by Mali *et al.* (2006) in the preparation of potato starch film by casting method was followed, the film solution was prepared by dissolving the starch with distilled water ($3g.100ml^{-1}$ solution) and adding 40% glycerol as a plasticizer ($g.100g^{-1}$ starch) and the volume was completed to 100 ml with distilled water. All components were mixed using a hot plate magnetic motor (Hot plate- Magnetic Stirrer) supplied by the German company Gellenkamp, until the temperature reached 95°C and within 10 minutes. The solution was cooled to 50° C and the film solution was poured into plastic plates. Starch gelatinization occurs at 60°Cand the final characteristics are strongly influenced by starch and plasticizer interaction. The dishes were dried at room temperature 25°C for 24 hours and the films were removed from the dishes and placed in polyethylene bags and stored in the refrigerator until used.

Oil extraction from rosemary leaves

The volatile oil was extracted in the laboratory of essential oils and medical at the College of Agriculture / University of Basrah, using water distillation according to the method mentioned by (Moss, 2003) was used (Clevenger) and conductor to a round glass flask size 1 litre weighed 30 g of leaves Rosemary and soaked in 30 ml of petroleum ether in a flask with a cover and stored at room temperature for the next day. The distillation was then performed 2.30 hours until the largest amount of volatile oil was obtained.

Preparation of rosemary composite films

The film with oil was prepared by adding rosemary oil of 2, 4, 6% (fat/starch weight) to the potato starch film solution. The method described by Veena *et al.* (2015) was followed in the preparation of the composite film. Rosemary essential oil at three different concentrations (2%, 4% and 6%) was added slowly with continuous stirring to film solution. The solution leaves until the temperature reached 95°C and for 10 minutes. The solution was cooled to 50°C and poured into plastic plates. The dishes were dried at room temperature 25°C for 24 hours. Then films were removed from the dishes and placed in polyethylene bags and stored in the refrigerator until used.

Study of effective groups by Fourier transform infrared spectroscopy technique (FTIR)

The effective groups of film samples were diagnosed after drying and grinding well in a ceramic mortar. The dried and powdered samples were mixed with 100:1 potassium bromide and pressed into the form of a thin tablet. The model was pressed into the infrared device supplied by the Japanese company Jasco used in the Department of Chemistry, College of Science, University of Basrah, according to Melo *et al.* (2011).

Thermo Gravimetric Analysis (TGA)

Thermogravimetric analysis of films was carried out at temperature range extended from room temperature to 700°C at a rate of $10°C.min^{-1}$under an atmosphere of nitrogen 20 $ml.min^{-1}$using the Q50V20.13 Build 39 TGA. It is located in the Department of Chemistry, College of Science, the University of Basrah according to the method mentioned by Senna *et al.* (2011). The samples were dried well and crushed with a ceramic mortar.

Determination of antioxidant activity

The determination of antioxidant activity was estimated by using a linoleic acid system for essential rosemary oil and film solutions proposed by Kudo *et al*. (2009). Concentrations of film solutions containing rosemary oil were prepared at a concentration of 2, 4, 6%. Then a mixture of 4.1 ml linoleic acid 2.5% ethanol concentration and 4 ml of the sample (oil, simple potato starch film solution, rosemary composite film solution, 8 ml phosphate buffer solution 0.05 molar at pH 7 and 3.9 ml distilled water) was prepared.

The mixture was incubated at 40°C for 24 hours in opaque containers. Thiocyanate oxidation was estimated by adding 0.1 ml of this mixture to 9.7 ml ethanol 75% concentration and 0.1 ml ammonium thiocyanate 30% concentration. 0.1 ml ferrous chloride 3.5% hydrochloric acid was added three minutes later then the absorption was measured at 500 nm. The control sample was prepared in the same way above by adding distilled water without the sample. The percentage of inhibition of linoleic fatty acid peroxides was calculated according to the following equation:

Antioxidant activity % =

$$\left[1-\left(\frac{\text{Sample absorbance}}{\text{Control sample absorbance}}\right)\right]x100$$

Ferric Reducing Antioxidant Power

The reduction potential of film solutions was determined by using the potassium ferricyanide ferric chloride method (Oyaizu, 1986). The control sample was prepared by adding all the previous materials, except the addition of simple and composite film solution. The absorption was measured at 700 nm. The following equation was applied:

Reduction power % =

$$\mathbf{100}-\left[\frac{\textbf{The absorbance of the model}}{\textbf{The absorbance of the control sample}}\right]\mathbf{x100}$$

Chelating of ferrous ion ability assay

Chelating of ferrous ion was measured by inhibiting the formation of fe^{+2}- ferrozine complex after treatment of test material with fe^{+2} following the method of Su *et al*. (2008). Absorption was measure at 562 nm. The control sample was prepared in the same way except for the addition of the sample. The chelating of ferrous ion was calculated according to the following equation:

Chelating of ferrous ion% =

$$1-\left[\frac{\text{The absorbance of the model}}{\text{The absorbance of the control sample}}\right]x100$$

Application

Packaging beef patties with simple starch film and a composite starch film with Rosemary oil by 2, 4 and 6%

Prepared beef patties from minced beef by electric mincing machine and added to the fat by 10% and minced meat again with the fat for homogenization. Salt was added by 2% to the minced meat product, then the meat was divided into five treatments A, B, C, D and E. As treatment B was covered with a simple potato starch film solution, treatment C, D, E was immersed in a compound potato starch solution with rosemary oil at a concentration of 2, 4 and 6%. As for treatment A, it was left without packaging to represent the control sample. The immersion process was carried out by immersing the meat patties in the film solution for five minutes, then removing the patties from the solution and placing them on a mesh tray of metal for 10 minutes, then they were left at room temperature until dry and then Beef patties were placed in polyethylene bags and stored in the refrigerator at 4-6°C for 10 days during which the change in peroxide number values was monitored. Beef patties were placed in polyethylene bags and stored in the refrigerator at 4-6°C for 10 days during which the change in peroxide number values was monitored.

Peroxide value determination

Peroxide value determination was estimated for beef patties as stated in AOAC (2000) for each treatment of the refrigerated samples and a period 10 days as measured peroxide value on the second day and the fifth day and the tenth day. The value of peroxide was then calculated from the following equation:

$$\text{Peroxide value} = \frac{\text{mI of Na2S3O4 X 0.01 standard x 1000}}{\text{Wt . of sample}}$$

Statistical analysis

Statistical analysis of treatment was conducted using a one-way ANOVA design (SPSS, 2019, version 24). Each treatment had three replicates. The significant level considered as 0.05.

Results & Discussion

Simple Starch Film:

According to visual examination, the obtained films were transparent, odourless, easy to handle. They were easily removed from the casting plates as in fig. (1) and this is similar to what Suput *et al*. (2016) obtained.

Fig. (1): Simple Potato Starch Film.

Starch films extracted from potatoes and incorporated with rosemary oil

The starch films extracted from potatoes and compounds with oil extracted from rosemary leaves were distinguished to easily remove from the mould and the films acquired the appropriate strength as a result of increasing the thickness of the films compared to the simple film without added oil as in fig. (2). This was due to the increase of the total solids of the film after the drying process and this was similar to what he found Resianingrum *et al*. (2016).

Fig.(2): Starch films installed with rosemary oil.

The thickness of the film prepared from cassava starch increased when the essential oil of cinnamon bark was added to Resianingrum *et al*. (2016) Indicated that the thickness of the cassava starch film increased by increasing the concentration of lemon essential oil from oils to starch films might induce a plasticizing effect that can improve the mechanical integrity of resulting films (Veena *et al.*, 2015).

Diagnostics of FT-IR Spectroscopy

FT-IR spectra could be used to determine molecular reactions and certain chemical components. Figs. (3-6) illustrate the results of the diagnosis of effective combinations of simple potato starch films and rosemary films at 2, 4 and 6% concentration. A wide beam of the spectrum at the wavelength of 3414.12cm^{-1} was observed due to the amplitude vibration of the hydroxyl groups OH. The intensity of this bundle varies according to the type of the reactants and the intensity of the reaction, and it expresses the increase of the hydrogen retention of the free and hydroxyl groups associated with the film-forming molecules (Haq *et al*., 2014), while the bands of the spectrum were observed at wave numbers 2931.90, 2889.46 and 2928.04 cm^{-1}. These peaks are attributed to the expansion and bending positions of the CH_2 aliphatic groups. at wavelength 1643 cm^{-1} a band appeared due to the amplitude oscillation of the carbonyl group C = O and the intensity of this region was often affected by the hydrogen bond (Wang *et al.,* 2010). The peaks are shown at range 1022.31, 1026.16 and 1157.33 cm^{-1} were due to the curvature of the C –O and C-O group resulting from the reaction of the glycerol added as a plasticizer (Garrido *et al.,* 2013).

Suput *et al.* (2016) noticed a very good correlation of the linear function, which was determined between the number of essential oils for both black cumin and black pepper and the FTIR spectra of the starch films while increasing the amount of oil. He mentioned deformation that occurs in the vibrations is due to the different functional groups present in both oils.

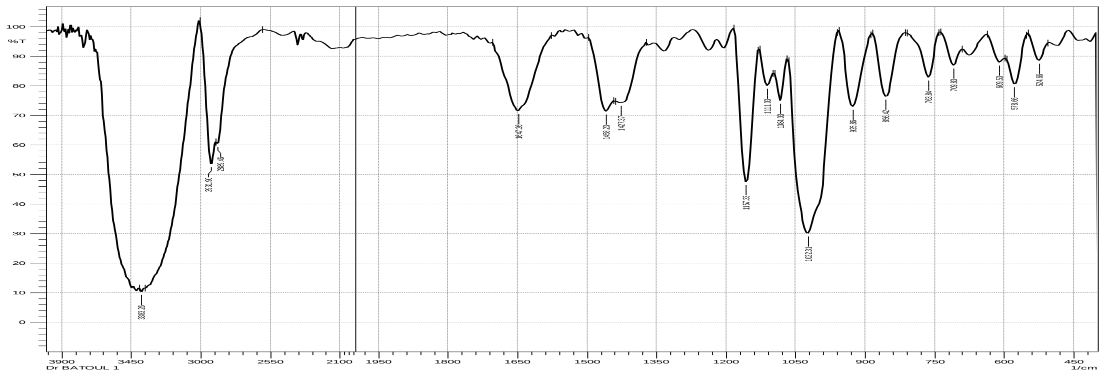


Fig. (3): Infrared spectrum of the simple potato starch film.

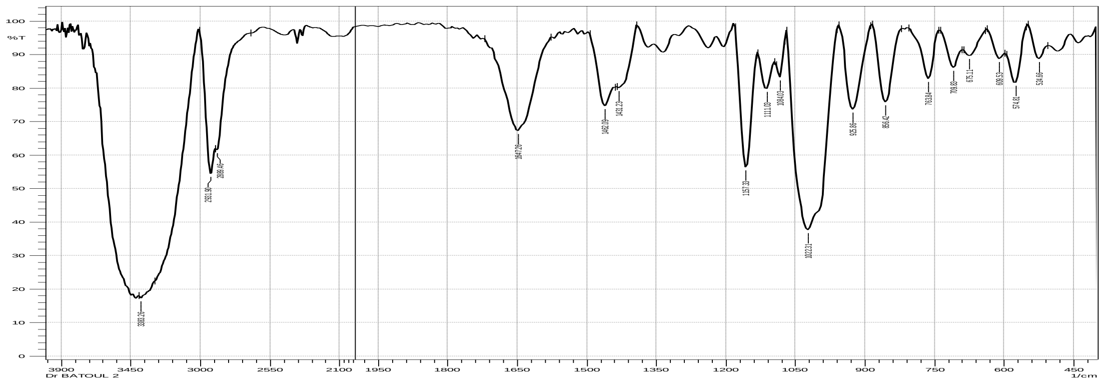


Fig. (4): Infrared spectrum of membrane potato starch with rosemary oil at a concentration of 2%.

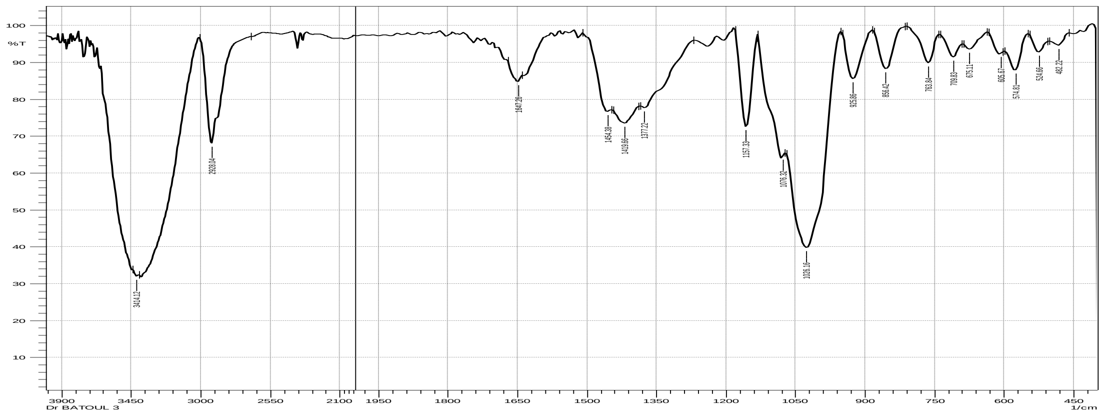


Fig. (5): Infrared spectrum of the compound potato starch film with rosemary oil at a concentration of 4%.

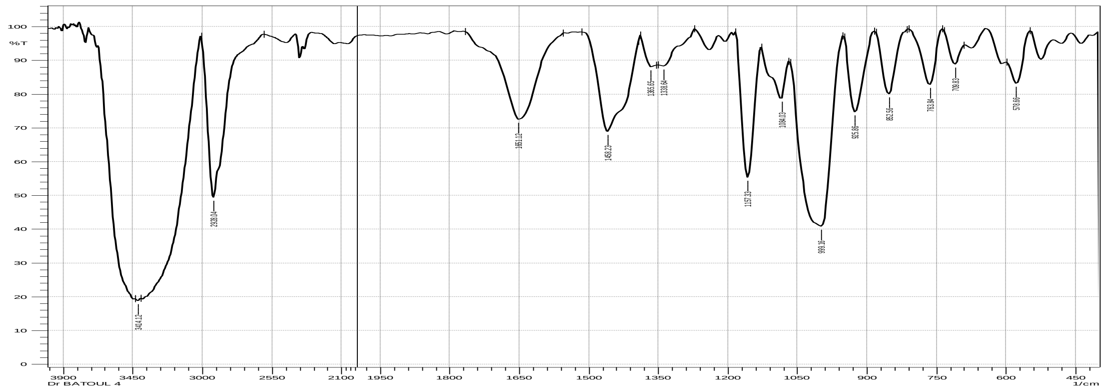


Fig.(6): infrared spectrum of the compound potato starch film with rosemary oil at a concentration of 6%.

Thermo Gravimetric Analysis (TGA)

Figs. (7-10) illustrated the gravimetric curves for the thermal stability of the potato starch films composite with rosemary essential oil of 2, 4, 6%. It was a technique in which the change in the mass of the sample was estimated by temperature, as weight loss and polymer degradation was observed in several stages, the first stage was a loss of weight by 2-10% at a temperature of 180.89, 200.10 and 325.15 ºC. The reason for the loss of weight was due to the disintegration and evaporation of free water associated with any loss of moisture in the base material of the film as the starch, starch had one stag of disintegration at approximately 300˚ C. The second stage was the main disintegration stage and started at a temperature of 300-400 C where the maximum disintegration occurred 338.47, 357.69 and 353.84˚C as in figs. (8-10).

Fig. (7) shows the thermal decomposition curve of the simple potato starch. Weight loss and decomposition of the compound were observed from the figure in several stages.

The first loss occurred at a temperature of 63.66C, which was attributed to the loss of moisture in the starch and the second major stage of the disintegration of starch, which started at a temperature of 180.89 C the maximum disintegration of starch occurred at a temperature of 338.47ºC. The reason for the disintegration was attributed to several reasons, which were the breakdown of most of the molecular structure of starch, which included the drying and polymerization of sugary rings, as well as the random breakage of the glycoside bonds, and the loss of bleeding water and the disintegration of the glycerol as a result of its evaporation or the presence of some incomplete crystallization. the second step occurred at 280 °C and the maximum degradation peak at 312 °C was related to starch chain decomposition. The second stage was the main disintegration stage and started at a temperature of 300-400°C where the maximum disintegration occurred 338.47, 357.69 and 353.84˚C as in figs. (8-10), which lost about 14-25% of its weight. The reason was due to the amount of base material remaining in the simple films being more compared to the amount in the films with oil added as a result of the change that occurred in the polymer network structure, which led to a decrease in the tensile strength of the film. While the amount of base material remaining in the simple film was higher than the amount. The amount of base material remaining in temperature 400-500ºC caused the removal of the carboxyl group as well as the decomposition of H and CH_2 bonds, the deterioration of the side chain and the loss of CO_2 which disintegrated at different temperatures sit could withstand the temperature up to 700 ºC. Therefore, had high thermal stability while the thermal stability of the oil films decreased due to the change in the structural composition of the film material. Diaz- Galido *et al.* (2020) stated that the maximum decomposition of the corn starch films incorporated with different concentrations of cinnamon oil and the emulsified substance (mucilage) was at a temperature of 312 ºC, as two phases of decomposition appeared, the first degradation step occurred up to 180 °C,

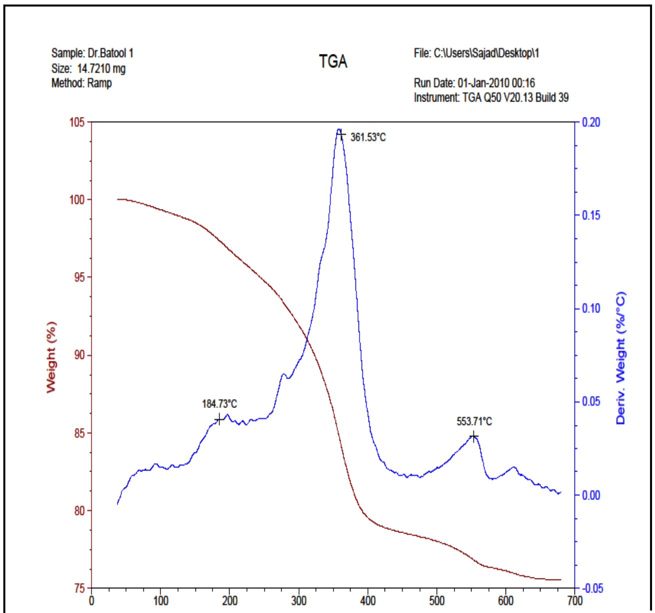


Fig. (7): Gravimetric decomposition of the simple& plasticized starch membrane with glycerol 40%.

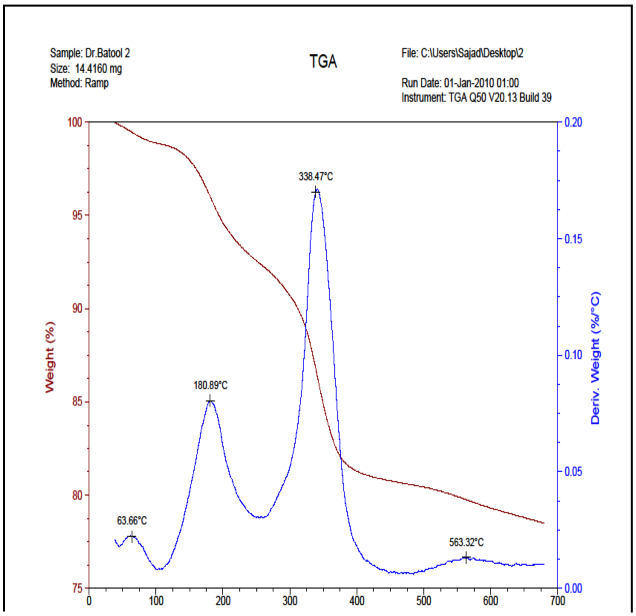
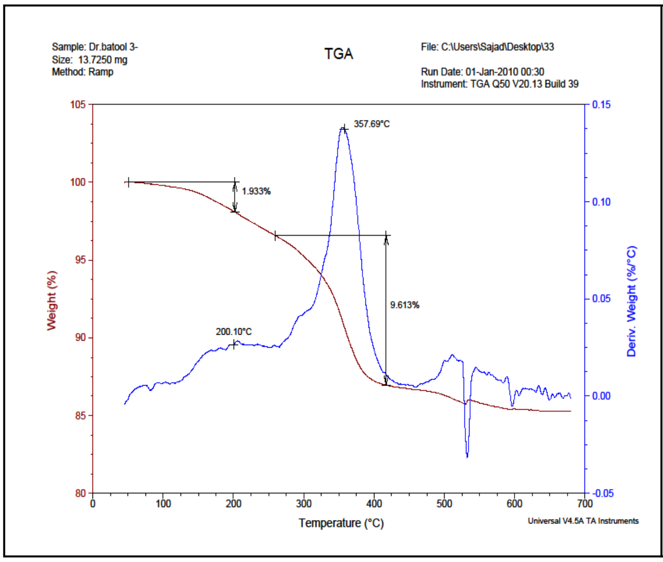


Fig. (8): Gravimetric decomposition of the potato starch membrane combined with rosemary oil 2%.



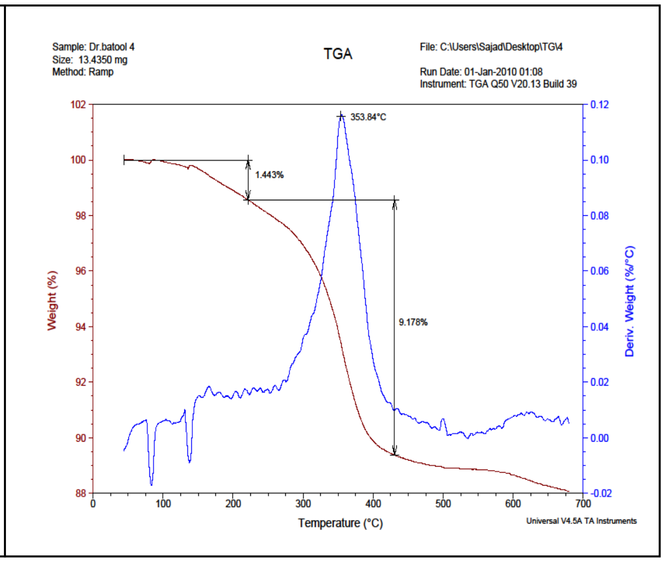


Fig. (9): Gravimetric decomposition of the potato starch film, which is combined with rosemary oil 4%.

Fig. (10): Gravimetric decomposition of the potato starch film, which is combined with rosemary oil 6%.

where bonded and boundless water was released whereas the second step occurred at

280 °C and maximum degradation peak at 312 °C were associated. With starch chain decomposition and Diaz- Galido *et al.* (2020) observed that the addition of emulsion did not affect the thermal degradation profile of thermoplastic starch.

The process of gravimetric thermal decomposition facilitated a knowledge of the stability of films. and their applicability in various application fields (Perazzo *et al.*, 2014).

Antioxidant activity

Table (1) demonstrates the results of the antioxidant activity of rosemary oil and simple potato starch film solution with rosemary oil concentrations of 2, 4, 6%. It was noted that the antioxidant activity of rosemary oil was 75.3%, due to the presence of some compounds that have antioxidant activity. Most of the studies reported that the antioxidant activity of essential oils is caused mainly by phenolic compounds (Suput *et al.*, 2016). According to Kadri *et al.* (2011), major oil components of rosemary oil included 1, 8 cineole, α-pinene, β-pinene, camphor, α-thujone and the-thujone (Kadri *et al.*, 2011); while simple potato starch films showed some antioxidant activity, they were 24.6% due to the presence of free radicals that could react with the remaining hydroxyl (OH) groups in the starch that formed large molecules. As (OH) groups can form ($+OH_2$) groups by absorbing the hydrogen ion from the solution (Tooraj *et al.*, 2012). The antioxidant activity of oil films increased by increasing the concentration of oil(56.4, 64.2, 70.1)% at concentrations (2, 4, 6) %. Significant differences in antioxidant activity were observed between the simple film and embedded films as well as significant differences in antioxidant activity were observed between films with different oil concentrations at probability level ($P < 0.05$). Pirouzifard *et al*. (2019) found that the potato starch composite film containing Zedo gum and *Salvia* essential oil showed excellent physical and antioxidant properties and had an excellent ability to be used in the food packaging industry. Al-Hashemi *et al.* (2020) found that the antioxidant activity of millet starch films incorporated with essential clove oil at a concentration of 1, 2 and 3% was due to phenolic compounds which present in the essential oil as Eugenol and the activity increased 15.96% with an increase in the essential oil concentration 3% compared to the activity of a simple starch membrane 0.3%**.**

Reducing power

Table (1) also indicates that the reduction potential of oil was 76.4%, while the reduction rate of the simple starch film was 21.8%. Whereas the reduced strength of the composite film with oil concentration of 2,4 and 6% increased by increasing the oil concentration as it was 55.1, 61.2 and 66.5% respectively. The reason for reductive power was due to the presence of active compounds involved in film synthesis, which reduced the ferric ion Fe^{+3} to the ferrous ion Fe^{+2} to avoid free radical reproduction by granting an electron, which in turn interacted with free radicals and turn them into more stable compounds and stopped the process of reproduction (Ruiz- Navajas *et al.*, 2013).

Chelating ferrous ion

It can be seen from the table (1) that the ferrous ion is binding capacity of rosemary oil 79.1%, While the ferrous ion bonding rate of

Table (1): Antioxidant activity, reducing power, the ability to bind ferrous of rosemary oil for simple and compact starch films, EO= essential oil.

Treatment (EO concentration %)	Antioxidant activity%	Reducing power %	The ability to bind ferrous ion %
0	24.6d ±3.37	21.8d ±3.43	31.7f ±4.33
2	56.4c ±3.49	55.1c ±4.41	53.6d ±3.61
4	64.2b ±3.98	62.2b ±4.76	62.4c ±4.22
6	70.1a ±3.46	66.5b ±4.88	73.7b ±4.36
EO	75.3a ±3.68	76.4a ±4.12	79.1a ±4.91

Vertically different letters mean significantly differ at $P < 0.05$ level.

the simple film was 31.7%, and the susceptibility of the added film with oil to bind ferrous ion increased 53.6, 62.4 and 73.7% by increasing the oil concentration respectively. This was due to the presence of active compounds in rosemary oil and film solution, which have antioxidant activity based on the composition of molecules containing hydroxyl aggregates which has a chelating property to bind catalytic metal ions (iron and copper) so it inhibited the formation of free radicals and therefore was not oxidation process had occurred. Al-Hashemi *et al.* (2020) reported that phenolic compounds are receptors for free radicals by breaking the chain oxidation reactions, which can be an indicator of the antioxidant capacity of the essential oil.

Peroxide Value (P.V)

Table (2) shows the peroxide values of beef patties stored at 4° C for 10 days; it is noticed from the table that there are significant differences between the peroxide values of the treatments and the significant differences between the peroxide values of the treatments and the control sample at the probability level ($P < 0.05$). As well as peroxide values were observed to decrease in treatments B, C, D and E compared to treatment A (control sample), the value of peroxide on the second day was 10 mEq.kg oil^{-1} and on the tenth day, it was 22 mEq.kg oil^{-1}, while the value of peroxide in the treatments B, C, D, E was lost. It was 11, 7.5, 6.5 and 5.2 mEq.kg oil^{-1}, respectively, for the tenth day, the height was slightly compared to treatment A (control sample). The peroxide values in B, C, D, E were lower compared to treatment A (control sample). The increases in peroxide values were attributed to the composition and oxidation of meat fats during storage, which led to the formation of peroxides and ketones (Al-Tai, 1987).

The decrease in peroxide values in beef patties covered with potato starch films and in combination with rosemary oil by 2, 4 and 6% may be due to the antioxidant activity of rosemary oil, which appeared by studying its antioxidant activity.

Table (2): Mean (± Standard Deviation) of treatments peroxide values (millilitres equivalent for each kilogram of oil) of beef patties stored at 4 ° C for 15 days covered with starch films installed with rosemary oil during different storage periods.

Treatments	Storage Periods/ day			
	0	**2**	**5**	**10**
A	0.00	10.00 a ±2.11	13.50 a ±2.10	22.33 a ±2.14
B	0.00	7.20 b ±1.22	8.50 b ±1.27	11.00 b ±1.19
C	0.00	5.40 c ±0.89	6.30 c ±1.33	7.50 c ±1.23
D	0.00	3.90 d ±0.66	5.10 cd ±1.21	6.50 cd ±1.16
E	0.00	2.60 d ±0.59	4.50 d ±1.18	5.20 d ±1.13

- Means with different letter vertically differ significantly at P <0.05

A = beef patties (control sample), B = beef patties covered with simple starch film C, = beef patties covered with starch synthesis with rosemary oil 2% D, = beef patties covered with starch synthesis with mountain rosemary oil 4% E, = Beef patties covered with starch film with rosemary oil 6%

The results were comparable to those found (Coskun *et al.*, 2014). Peroxide values of beef patties coated with simple soybean films and films with oregano oil and stored in refrigerated oil for 12 days were found to decrease with increased storage time compared to uncovered beef patties. Vital *et al.* (2016) found that the active edible coating containing rosemary and oregano essential oils had potential applications in animal meat products to maintain/improve their characteristics during the shelf-life.

Conclusion

The results of this study demonstrated that rosemary oil can be successfully incorporated into potato starch edible films, which showed significant antioxidant properties. These properties may be due to its excellent antioxidant activities coming from the rosemary. Then corporations of rosemary oil to potato starch edible films may have supplementary applications in food packaging to improve the oxidative stability of foodstuffs.

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Conflict to interest

There is no conflict of interest.

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تحسين الفعالية المضادة للأكسدة لأغشية نشا البطاطا القابلة للأكل المدمجة بزيت اكليل الجبل *Rosmarinuso fficinalis* L. واستعمالها في تغليف اقراص اللحم البقري

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المستخلص: الغرض من هذه الدراسة هو تقدير الفعالية المضادة للأكسدة للأغشية القابلة للأكل والمحضرة من النشا المستخلص من البطاطا والمركبة بالزيت العطري المستخلص من اوراق نبات اكليل الجبل بتركيز 2 و4 و 6 % واستعمالها في تغليف اقراص اللحم البقري المخزنة على 4 – 6 م° لمدة 10 ايام. بينت النتائج بان الفعالية المضادة للأكسدة والقوة الاختزالية وقابلية ربط ايون الحديدوز ازدادت مع زيادة تركيز الزيت اذ بلغت 70.1 و 66.5 و 73.7 % على التوالي عند تركيز6% زيت. كما اجري فحص التحلل الوزني الحراري وتشخيص المجاميع الفعالة للأغشية البسيطة والمركبة بالزيت. وتمت متابعة التغيرات التي تحدث في قيم البيروكسيد لأقراص اللحم البقري المغطاة بأغشية النشا البسيطة والاغشية المركبة بالزيت وقد اظهرت النتائج المغلفة مقارنة مع انخفاض قيم البيروكسيد في المعاملات المعاملة الضابطة التي لا تحتوي على الزيت. وكان تأثير اضافة زيت اكليل الجبل ايجابيا في اطالة مدة حفظ اقراص اللحم البقري طول مدة الخزن.

الكلمات المفتاحية: غشاء قابل للأكل، مضاد للأكسدة، نشا، تحلل وزني حراري، زيت عطري.