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Extracting β-glucan from Saccharomyces cerevisiae and using it as an alternative to fat to improve certain qualities in refrigerated beef

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Abstract: Extracting, diagnosing β-glucan from yeast *Saccharomyces cerevisiae*, its antioxidant activity and the reduction of β-glucan strength were measured by its ability to detect hydrogen peroxide and to bind iron, besides using it as an alternative for fat and reducing its oxidation indices in refrigerated meatballs. The results confirmed β-glucan as a natural oxidant for tocopherol. The antioxidant activity was 80% with an average of 92.49% for β-glucan. Asymptotic to industrial anti-oxidants BHT, β-glucan was also in its reduction and hydrogen peroxide concentration to the Butylated Hydroxy Toluene oxidant and its results to ascorbic acid. The addition of beta-glucan yeast significantly decreased the ratio of free fatty acids, peroxide value and the prolongation of the period of conservation of meat in the refrigerator up to 12th day, as compared to control, which was excluded on the seventh day of conservation due to its high oxidation indices, accompainied to a significant decrease in the amount of cholesterol from 1.23 $mg.g^{-1}$ in the control sample on the seventh day to 0.53 $mg.g^{-1}$ on the 11^{th} day in meat tablets treated with 4% β-glucan kept in the refrigerator.

Keywords: β-glucan, antioxidant, meat products, cholesterol

استخلاص بيتا كلوكان من خميرة الخبز *Saccharomyces cerevisiae* واستخدامه بديلا عن الدهن لتحسين بعض الصفات النوعية في اقراص اللحم المحفوظ بالتبريد

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المستخلص :

هدفت الدراسة الحالية استخلاص وتشخيص β-كلوكان خميرة الخبز *Saccharomyces cerevisiae* وتم قياس فعاليته المضادة للأكسدة وقياس القوة الاختزالية لـβ-كلوكان مع قياس قابليته على اكتساح بيروكسيد الهيدروجين وقدرته على ربط ايون الحديدوز واستخدامه بديلا عن الدهن وخفض مؤشرات الاكسدة في اقراص اللحم المحفوظ بالتبريد. اوضحت نتائج الدراسة تفوق معنوي لبيتا كلوكان الخميرة كمضاد كسدة طبيعي على مضاد الاكسدة التوكوفيرول اذ بلغت الفعالية المضادة للأكسدة 80% فيما بلغ المتوسط 92.49% لـβ-كلوكان وكان مقارب إلى مضاد الاكسدة الصناعيButylated Hydroxy Toluene ، كما تفوق بيتا كلوكان في قوته الاختزالية واقتناص بيروكسيد الهيدروجين على مضاد الاكسدة Butylated Hydroxy Toluene ومقارب في نتائجه الى حامض الاسكوربك. كما اوضحت نتائج الدراسة ان اضافة بيتا كلوكان الخميرة ادى الى انخفاض معنوي في نسبة الاحماض الدهنية الحرة ورقم البيروكسيد واطالة فترة حفظ اللحوم بالتبريد الى اليوم الثاني عشر مقارنة بعينة السيطرة التي استبعدت في اليوم السابع من الحفظ نتيجة ارتفاع مؤشرات الاكسدة فيها مع انخفاض معنوي في كمية الكولسترول من 1.23 ملغم/غم في عينة السيطرة في اليوم السابع الى 0.53 ملغم/غم في اليوم الحادي عشر في اقراص اللحم المعامل بـ 4% β- كلوكان المحفوظة بالتبريد.

Introduction

Many negative aspects associated with processed meat products can be overcome by reducing unhealthy ingredients such as saturated fats that have adverse effects (including obesity, high cholesterol, cardiovascular disease, diabetes, and several types of cancer) (Mora-Gallego *et al*., 2016). The introduction of biologically active ingredients for health promotion, such as the addition of natural antioxidants (Grasso *et al*., 2014; Jiang and Xiong, 2016) and dietary fiber (Grasso *et al*., 2014; Resconi *et al*., 2016). Functional meat products have become particularly widespread by health-conscious consumers. Studies suggest that dietary fiber can be used to improve the technological and sensory properties of processed meat products (Grasso *et al*., 2014; Shan *et al*.، 2017).

Materials and methods of work

Extract β-glucan from the baker's yeast S. cerevisiae

The extraction process was performed on the basis of acid, base, and other organic solvents.

β-glucan was extracted from the *S. cerevisiae* according to Byron (1993) method.

Preparation of Yeast Glucan Using Acetone

1- Approximately 200 grams of Brewer's yeast was dispersed in one liter of 1.5 normal sodium hydroxide. The mixture was stirred until homogeneous then autoclaved for one hour.
2- calved material was centrifuged at 3,000Xg for 15 minutes, discarding the supernatant and retaining the alkaline insoluble residue. The alkaline insoluble residue was washed three times, each wash consisting of one liter of distilled water with centrifugation at 3,000Xg
3- for 15 minutes to pellet the solid material and discarding the supernatant liquid. The water-washed residue was then stirred into warm (85 C.) 3% acetic acid solution and stirred for approximately 3 hours. The acid solution was then centrifuged one time as described above and
4- the acid insoluble residue resuspended in one liter of distilled water. The washed acid insoluble residue was then resuspended in 600 milliliters of 100% ethanol. The solid residue was again pelleted by centrifugation at 3,000Xg for 15 minutes. The ethanol-washed residue
5- was resuspended in approximately 600 milliliters of acetone and again centrifuged at 3,000Xg for 15 minutes. The acetone-washed residue was mixed with the residual acetone in the centrifuge tube and then was collected in a sintered glass funnel. The acetone was drawn from the glass funnel by vacuum. The collected solid material was scraped from the funnel into small Petri dishes. The Petri dishes were then placed into a desiccator and dried under vacuum. Clumps of dried material were broken up with a spatula and placed into a storage container.

Measure antioxidant Activity

The antioxidant efficacy was estimated by using linoleic acid maturation according to the method described by Mitsuda *et al*. (1966) mentioned in Gulcin *et al*. (2003) using the linoleic acid system.

The reaction mixture consists of 4.1 mL of linoleic acid (2.5% ethanol), 4 ml of an cohol extract and 8 ml of 0.05 molar of pH-regulated solution 7, 3.9 ml of distilled water and 1 ml of 80% Ethanol) and incubated at 40 ° C for 24 hours.

Thiocyanate was estimated by taking 0.1 ml of the mixture and adding 9.7 ml of 75% ethanol and 0.1 ml of ammonium thiocyanate (30% concentration). Three minutes later, 0.1 mL $FeCI_2$ (0.02 mL concentration in 3.5% Hydrochloric acid).

The absorbance was measured at a wavelength of 500 nanometers. BHT was used for comparison. The control sample was obtained in the same way as the above, except mixing 4 mL ethanol of β-glucan. The percentage of inhibition of linoleic acid peroxides was calculated according to the following equation:

Antioxidant Inhibition% = 100 – (Absorption of the sample/ control of absorbent sample Reading) x 100

Measurement of Reducing Power

The method of Oyaizu (1986) which included mixing 2.5 ml of extract β-glucan, BHT and ascorbic acid with 2.5 mg phosphate solution, 200 mg molar, 6.6 pH and 2.5 ml of potassium ferricyanide solution (1% Mix the mixture at 50 ° C for 20 minutes and then terminate the reaction by adding 2.5 mL Trichloroacetic acid (10%). The central dissipation of the mixture was performed at 2000 cycles / min for 10 minutes. Separate the top layer of the solution and add 5 ml of distilled water and 1 ml of ferric chloride (0.1%). Measure the absorbance at a wavelength of 700 nanometers. The control sample was all the previous substances except addition of 2.5 mL ethanol instead of the β-glucan extract. The following equation was applied to calculate the amount of reduction power of the extract:

Reducing Power % = 100 – (Absorption of the sample/ control of absorbent sample Reading) x 100

Hydrogen peroxide scavenging capacity

The ability of β-glucan to capture hydrogen peroxide was determined according to the method mentioned in Turkoglu *et al*. (2010) by taking 1 ml of extract β-glucan 0.5 mg / mL and 0.6 ml of 0.002 m of hydrogen peroxide recorded in Phosphate precipitate 0.1 molars at pH 7.4; samples were then left for 10 min at laboratory temperature. Absorption was measured along a wavelength of 230 nm. The results were compared with BHT and ascorbic acid. The ability to capture hydrogen peroxide was determined according to the following equipment:

Hydrogen peroxide scavenging capacity% = (absorbance of the control reaction- absorbance the sample / absorbance of the control reaction) x 100.

Iron-ion bind

The ability of β-glucan to bind iron was estimated by following Gulcin *et al*. (2003), containing 0.4 ml of extract with 0.4 mL of 2-mM iron chloride with 0.4 mL 8-hydroxyquinoline at a concentration of 5 molars (98% ethanol). Incubate the mixture for 10 minutes at room temperature in a dark place. Absorption was measured along a wavelength of 562 nanometers. The ability to bind the iron ion to the Ethylene diamine tetraactic acid (EDTA) and sodium citric acid was estimated in the same manner except for the addition of the extract. The viability of β-glucan was calculated on the iron-iron binding according to the following equation:

Connectivity %= (1- Absorption of the sample / absorbance of the control reaction) x100.

Diagnosis of β- glucan using Fourier transform infrared

The FTIR device was used to diagnose and detect β-glucan. The method included mixing a quantity of colloquium extract with a quantity of potassium bromide salt (BrK) 10: 1 (model: potassium bromide salt). After mixing the materials, mix the mixture well and then placed on a transparent disc and distributed in a homogeneous and light layer and then pressed by the piston, and then extracted the disc carefully and gently and placed on a special platform installed device, (FTIR) (Naja *et al.*, 2005).

Process of manufacturing and processing minced meat

The meat was minced by the electric frying machine and the fat was added to some of the treatments by 15% and mixed well. B-glucan was added and the coefficients were distributed as follows:

1. Treatment of control Add 15% fat to meat without adding β-glucan

2. Second treatment: 15% fat supplemented with 1% β-glucan supplement.

3. The third treatment added 1% β-glucan of meat without adding fat.

4. Fourth treatment Add 15% fat to the meat with the addition of 2% β-glucan.

5. Fifth treatment added 2% β-glucan of meat without adding fat.

6. Sixth treatment: 15% fat supplemented with 4% β-glucan.

7- Treatment 4% β-glucan was added to the meat without adding fat.

The meat tablets were weighed 100 g for each sample and kept refrigerated until tests were carried out.

Free Fatty Acid %

Free fatty acids (F.F.A) were estimated based on Pearson *et al*. (1981) by:

Free Fatty Acid% = (Titration (A-B) x N x282 x 100) / (1000 x Wt. of Sample gm)

A = Number of KOH of the sample.

B = Number of KOH of the Blanc

282 = Molecular weight of oleic acid

Peroxide value

The peroxide value was estimated by Pearson *et al*. (1981) using the following equation:

Peroxide value = (ml x Nx1000 $Na_2S_3O_4$) / (Wt. of Sample gm).

Estimate the concentration of cholesterol in the meat

The cholesterol concentration of the meat tablets used in the study was measured according to method al-Obeidi (1999), modified by Salhi (2012), and the concentration of cholesterol was extracted by applying the following equation:

Cholesterol concentration (mg / g) = (model reading) / (standard cholesterol reading) x 2

Sensory tests

Followed the way described by Levie (1970)

statistical analysis:

Results were statistically analyzed using a complete randomized design (CRD) experiment and statistically analyzed data using SPSS (2012). The results were compared using the lowest mean difference (RLSD) at the probability level ($p < 0.05$) **(**Al-Rawi and Khalaf Allah, 2000).

The process of extracting and adding dietary fiber, β-glucan, to food components has beneficial effects by modifying the structural properties and improving the stability of emulsions during storage, as well as its ability to increase the viscosity of aqueous solutions and the formation of stable gelatin (Santipanichwong and Suphtharika, 2009) Glucan as a good alternative to fat in processed meat products and other food products (Morin *et al*. 2002; Worrasinchai *et al*., 2006).

Due to the lack of studies related to the use of β-glucan in processed meat products and the importance of the subject, the present study aimed to extracting and diagnosing β-glucan from *Saccharomyces cerevisiae* and using it as an alternative to fat and improving certain qualities of refrigerated meat tablets.

Results and discussion

FT-IR examination

The result of the test shown in Figure (1) shows that the spectral spectrum of the model contains absorption at the waveform (894 cm -1), characteristic of the type β- (1.3) (Hozova *et al*., 2007). Hyun *et al*., 2007). The model also contained absorption at the waveform (1041 cm -1), which also indicates the presence of (1.3) β-glucan (Hozova *et al.*, 2007; McCann *et al*., 2007).

The presence of (1.3) β-glucans is also indicated by the presence of absorbance at wave numbers (1257, 1303 and 1365) (Karreman *et al.*, 2006; Corredor *et al*., 2007; Hozova *et al*., 2007).

Measure the effectiveness of antioxidant outside the body

The results of Figure (1) show the effectiveness of β-glucan against the oxidation of linoleic acid compared to Butylated Hydroxy Toluene and Tocopherol. It is clear from the that β-glucan showed significantly higher antioxidant activity compared with antioxidant tocopherol, with a concentration of 86.49% at 25% and 87.03% The concentration was 50% and showed the highest antioxidant effect at 100% concentration. The average was 92.49%. This was superior to the antioxidant tocopherol, which showed the highest efficacy at a 100% concentration of 80% and close to what was shown by the industrial antioxidant BHT, which has an antioxidant effectiveness of 95% at the concentration of 100%. Is due to the high efficiency of β-glucan Active compounds that either give hydrogen and electrons or have the ability to capture free radicals or possess causal agents to bind the catalysts to the oxidation process

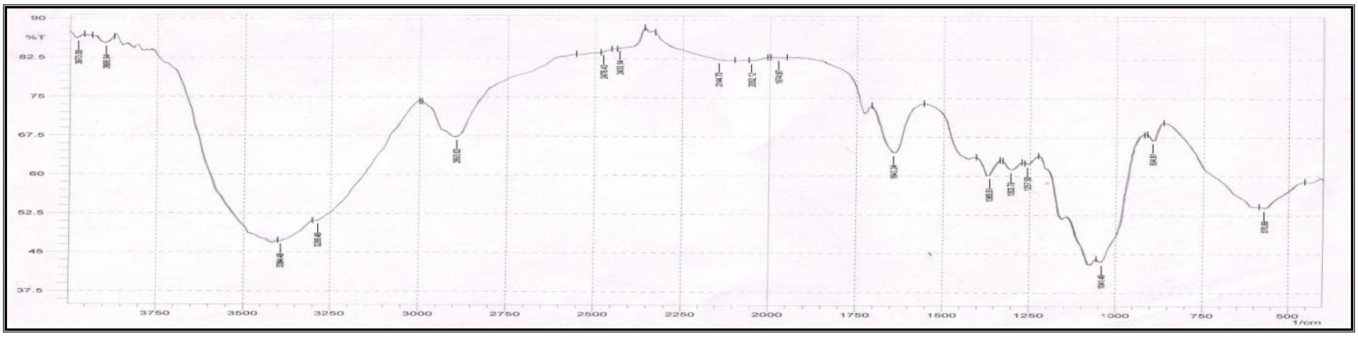

Figure :1 Infrared spectrum of β-glucan which was extracted by method Byron

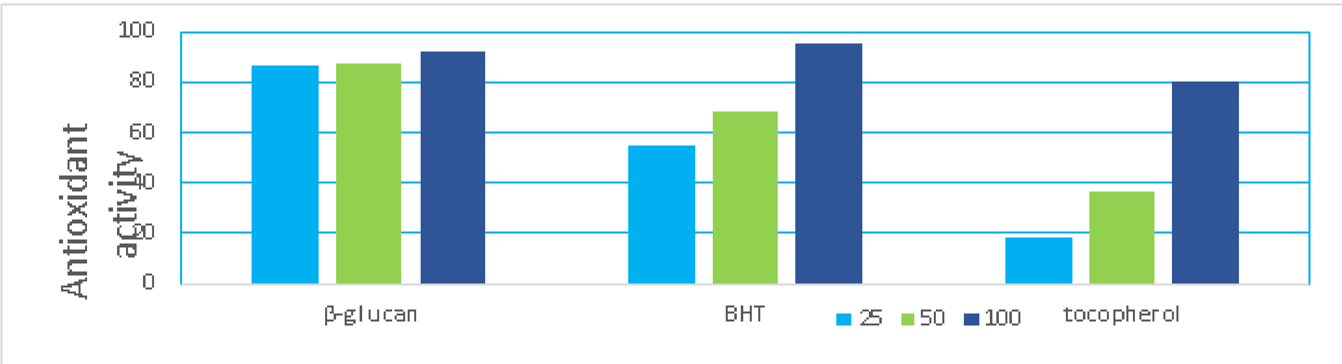

Figure :2 Effect of β-glucan anti-oxidation of linoleic acid.

Measuring the power of reduction

The results of Figure (2) the show reduced strength of β-glucan compared with the natural antioxidant ascorbic acid and the industrial antioxidant BHT. It has the ability to reduce the Fe^{+3} ferric ion in the Potassium Ferricyanide complex [KFe (CN)) to Fe^{+2} The results showed that β-glucan had a reduction of 1.41% at a concentration of 25% and a maximum mean of 2.9% with 100% a concentration of 100%, which was significantly higher than BHT, which reached an average of 2.4% at 100% and ascorbic acid 2.5% for the same concentration of the antioxidant standard ascorbic acid and indicate the intensity of the color on the reduction force For Michels (Chun *et al*., 2005).

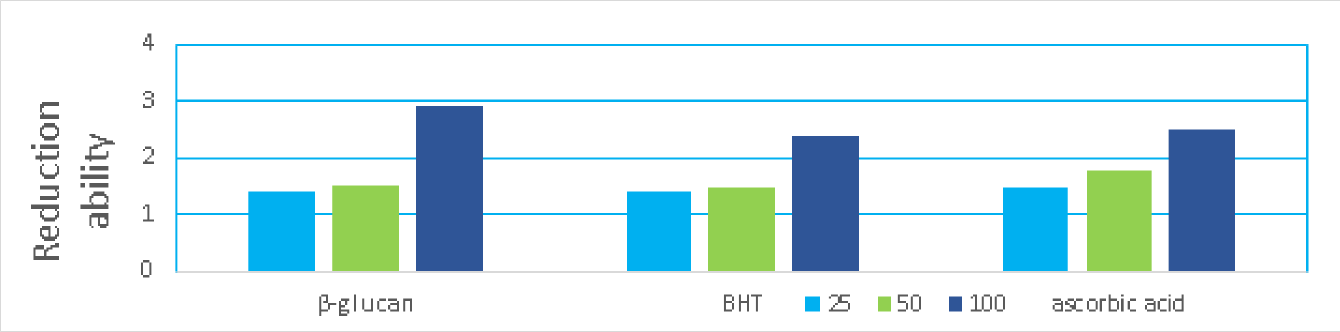

Figure :3 The mitral power of β-glucan

Hydrogen peroxide capture capacity

The results of Figure (4) show that β-glucan's hydrogen peroxide uptake is superior to the industrial antioxidant BHT, with significant differences (P <0.05). The averages for β-glucan were 45% for the concentration 25% and 60% for the concentration 50% and 88% for 100% There was also no significant difference between β-Glucan and the standard compound ascorbic acid in its ability to sweep hydrogen peroxide at 100% concentration with an average of 88 and 92%, respectively.

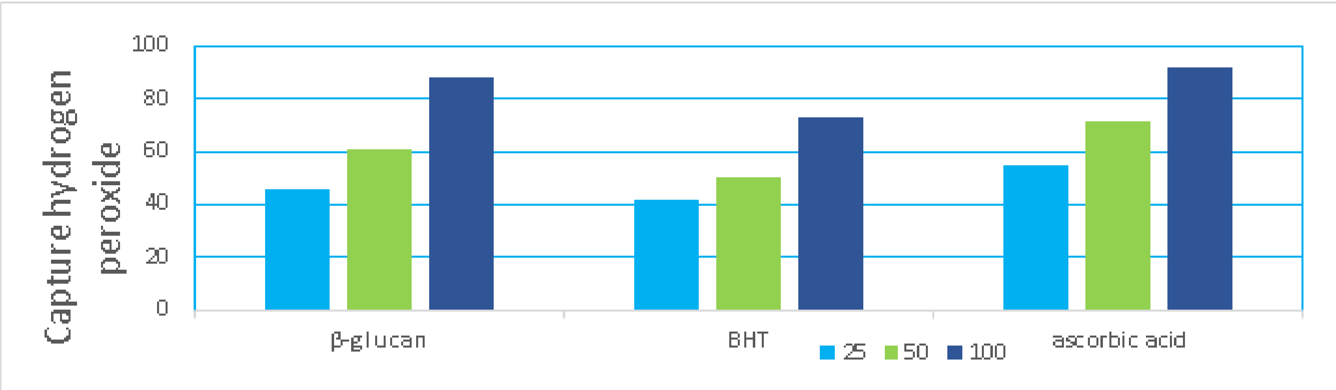

Figure :4 The ability of β-glucan to capture hydrogen peroxide.

Iron-ion bind

The results of Figure (5) show the ability of β-glucan to bind iron ions compared with the industrial antioxidant EDTA 2Na and citric acid. The results showed high and significant susceptibility of β- glucan to iron-iron binding compared to EDTA. The concentration of the extract to the highest mean was 75 and 80% at the 50 and 100% concentrations respectively, while the average correlation of iron irradiation to the industrial antioxidant at the same concentrations 60 and 73%, respectively. When compared with the standard antioxidant (citric acid), the results showed that the correlation between β- glucan and Ferro- iron was almost identical to that of the standard antioxidant, especially at 100% concentration, where the average was 80 and 83%, respectively. Nagulendran *et al*. (2009) explained the reason for the ability of the plant extract to bind iron irons. The ability of phenolic compounds such as phenols, tannins and flavonoids to bind iron ions such as iron and copper depends on their content of multiple hydrogen aggregates and their ability to give hydrogen to capture these ions. Superior to industrial antioxidant.

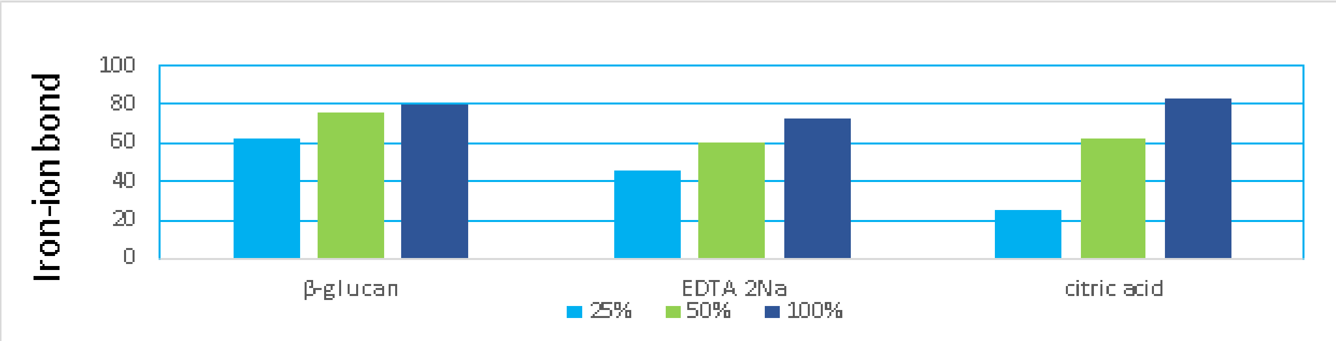

Figure :5 The susceptibility of β-Glucan to the iron-ion bond.

Free Fatty Acids%

The results of Table (1) showed a significant decrease ($p < 0.05$) in the ratio of free fatty acids in meat tablets treated with different concentrations of β-glucan compared to control sample during storage periods at 4°C. 1.36% on the seventh day of cryopreservation and thus exceeded the limits of the standard and excluded from the experiment because of the high indicators of oxidation In the addition of β-glucan kept the meatballs to stay within the permissible limits of free fatty acid content to be excluded as the duration of exclusion According to different concentration and (0.74%, 0.64%, and 0.61% respectively) for concentrations 1, 2 and 4% respectively on the ninth, tenth and eleventh consecutive days. The reason for may be due to the ratio of free fatty acids to β-glucan yeast, which is considered a natural antioxidant. B-glucan contains high amounts of biologically active phenolic compounds (Omana *et al*., 2011; Thondre *et al*., 2011). This may be due to the inhibitory effect of β-glucan towards, which are responsible for the damage and spoilage of meat and meat products. Crystalline storage of β-glucans has been used to prolong the duration of the meat-preserving period compared to the control sample (Ozcan and Ertan, 2018).

The study did not show any significant differences in the percentage of free fatty acids in meat tablets when adding or not adding fat by 15%, where it is noted from the table that the average ratio of free fatty acids 0.66 and 0.64 when adding 2% β-glucan only or with 15% 0.69 and 0.61 when β-glucan was added to only 4% or 15% fat on the 11th day. Although there were no significant differences between the added treatments, equal concentrations of β-glucan with 15% lipid and β-glucan without fat but the latter Recorded the lowest averages.

Table (1). Effect of the use of different concentrations of β-glucan yeast in the values of the ratio of free fatty acids to minced meat tablets refrigerated stock at a temperature of 4 °C

Treatment	Duration Save (day)					
	0	4	7	9	10	11
15% fat control	0.33	0.70 a	1.36 a	-	-	-
β-glucan 1% + fat 15%	0.32	0.52 b	0.70 b	0.77 a	-	-
β-glucan 1%	0.32	0.52 b	0.69 b	0.74 a	-	-
β-glucan 2% + fat 15%	0.32	0.51 b	0.63 bc	0.65 ab	0.66 a	-
β-glucan 2%	0.32	0.51 b	0.63 bc	0.63 ab	0.64 a	-
β-glucan 4% + fat 15%	0.31	0.44 b	0.45 c	0.54 b	0.59 a	0.69
β-glucan 4%	0.31	0.42 b	0.42 c	0.49 b	0.56 a	0.61

The averages in a single column with different letters differ significantly at the 5%

Peroxide Value

The results of Table (2) show a significant decrease (p <0.05) in the value of the number of seventh day of conservation the control sample, the peroxides Value exceeded the limits of the standard and were excluded from the experiment due to the high oxidation indices in them, while the meat tablets added 1, 2 and 4% β-glucan kept them within the permissible limits of the ninth and tenth day and the 12th day of concentration 4 (3.44, 3.04 and 2.67) (EQ / kg) respectively, showing a significant superiority of 4% β-glucan concentration to prolong the duration of freezing meat until 12 days. This may be due to β-glucan's ability to capture free radicals because it contains phenol and polyol compounds Phenol and natural antioxidants (Thondre *et al*., 2011)

The table also shows a significant reduction in peroxide in meat tablets, which are refrigerated at a temperature of 4c with an increased peroxides of meat tablets treated with different concentrations of β-glucan compared to the control treatment during the period of Keep meat refrigerated at 4 m 6.95 meq / kg meat at the concentration of added β-glucan. This is due to β-glucan's susceptibility to natural oxidation Where its impact increases with the increase in concentration (Omana *et al*., 2011).

The results of Table (2) also shown that the addition of fat by 15% to the with the presence of β - Glucan did not significantly affect, where kept meatballs within the limits of the standard until the end of the period of storage in the refrigerator, This is an encouraging result of the use of β-glucan as an alternative to fat in the manufacture of meat products because of the negative effects on public health related to heart disease and high arterial pressure. Some studies have demonstrated the potential of β-glucan as an anti-oxidant inhibitor of free radicals and reduce its activity on its antioxidant effect on lipid peroxidation (Kayali *et al*., 2005; Jaehrig *et al*., 2007).

Table (2). Effect of the use of different concentrations of β-glucan in yeast in the number of peroxides of minced meat tablets, refrigerated at 4 °C

Treatment	Duration Save (day) 0	4	7	9	10	11
15% fat control	2.23	3.43 a	6.95 a	-	-	-
β-glucan 1% + fat 15%	2.22	2.50 b	3.15 b	3.59 a	-	-
β-glucan 1%	2.22	2.39 b	3.12 b	3.44 a	-	-
β-glucan 2% + fat 15%	2.21	2.38 b	2.76 c	3.03 b	3.12 a	-
β-glucan 2%	2.21	2.23 b	2.69 c	2.98 b	3.04 a	-
β-glucan 4% + fat 15%	2.20	2.23 b	2.23 d	2.24 c	2.32 b	2.85
β-glucan 4%	2.20	2.20 b	2.21 d	2.24 c	2.25 b	2.67

• The averages in one column with different letters differ significantly at the 5%

Cholesterol

The results of Table (3) showed a significant effect ($p<0.05$) in the amount of cholesterol for meat tablets treated with different concentrations of β-Glucan. The treated meat tablets recorded the lowest cholesterol averages of 0.89 and 0.69 and 0.56 mg / g for concentrations 1, 2 and 4%, respectively, at the start of the experiment with refrigeration, which is lower than the average cholesterol levels in meat tablets in the control sample with an average cholesterol level of 1.23 mg / g. As the periods of cryopreservation increased, β-glucan was observed to reduce the amount of cholesterol in the samples added to concentrations 1, 2 and 4%. The samples on day 11 were(0.83, 0.65 and 0.53) mg / g respectively, Superior to the control sample in which it is reached Mean cholesterol was 1.12 mg / g after only seven days of cryopreservation. This may be due to the fact that β-glucan contains antioxidants that have the ability to inhibit free radicals, reduce fat oxidation and β-glucan ability to reduce and lower cholesterol (El-Sherbiny *et al*., 2003).

Table (3). Effect of the use of different concentrations of β-glucan yeast in the cholesterol ratio of minced meat tablets refrigerated at 4°

Treatment	Duration Save (day) 2	7	11
15% fat control	1.23 a	1.12 a	-
β-glucan 1% + fat 15%	1.09 b	1.04 b	1.01 a

β-glucan 1%	0.89 c	0.86 c		0.83 b
β-glucan 2% + fat 15%	0.77 d	0.75 d	0.72 c	
β-glucan 2%	0.69 e	0.67 e		0.65d
β-glucan 4% + fat 15%	0.63 f	0.61 f		0.59 e
β-glucan 4%	0.56 g	0.54 g		0.53 f

• The averages in one column with different letters differ significantly at the 5%

Sensory assessment

The results in Table (4) indicate an improvement in sensory characteristics (color, flavor, tenderness, Juiciness and Over all acceptability) In treatments with added β-glucan compared to control treatment The highest scores were recorded for color and flavor status and significantly higher for the added β-glucan treatments, which increased their concentration by increasing their concentration until they reached a very good grade (8.75) at the concentration of 4% at the beginning of conservation and on the sixth day of the cold preservation of both grades, Either control treatment did not exceed the average score. Also indicate the results shown in the table (4) to the presence of superiority significantly ($p < 0.05$) in the character of tenderness and juiciness transactions with added β-glucan has got the highest grades at the concentration of 4%, which was 8.00 compared to the treatment of control that did not exceed the degree of average. The results shown in Table (4) indicate that there is a significant superiority of the Overall acceptability of the added β-glucan, with average, good and very good concentrations of concentrations 1, 2 and 4%, respectively, at the beginning of conservation and on the sixth day of cryopreservation, To the treatment of control that did not exceed the grade of average.

These results confirm Gago *et al* (2011), which improved significantly the sensory properties when using β-glucan with concentrations of 3% and 8% in the preservation of cryotherapy chicken meat.

Conclusions

The possibility of using β-glucan as a natural antioxidant as an alternative to industrial antioxidant and that β-glucan was a good substitute for fat and a significant improvement in meat tablets through a significant improvement in quality traits.

Table (4). Effect of the use of different concentrations of β-glucan yeast in the sensory characteristics of minced meat tablets, refrigerated stock at 4°C

Treatment	color		flavor		Tenderness		Juiciness		Over all acceptability	
	0 day	6 days	0 day	6 days	0 day	6 days	0 day	6 days	0 day	6 days
Control fat 15%	5.00 a	5.00 a	5.00 a	4.50 a	6.25 a	6.00 a	5.25 a	5.25 a	5.00 a	4.75 a
β-glucan 1% + fat 15%	5.75 b	5.75 b	5.75 b	5.75 b	7.00 b	6.75 b	6.25 b	6.25 b	5.75 b	5.75 b
β-glucan 1%	5.75 b	5.75 b	6.00 b	5.75 b	7.00 b	6.75 b	6.50 b	6.50 b	6.00 b	6.00 b

β-glucan 2% + fat 15%	6.50 c	6.50 c	6.75 c	6.50 c	7.75 c	7.50 c	7.50 c	7.50 c	6.25 b	6.25 b
β-glucan 2%	7.50 d	7.50 d	7.50 d	7.50 d	7.75 c	7.50 c	7.75 c	7.75 c	7.50 c	7.50 c
β-glucan 4% + fat 15%	7.75 d	7.50 d	7.50 d	7.50 d	7.75 c	7.75 c	7.75 c	7.50 c	7.50 c	7.25 c
β-glucan 4%	8.75 e	8.75 e	8.75 e	8.75 e	8.00 c	8.00 c	8.00 c	8.00 c	8.50 d	8.50 d

The averages in a single column with different letters differ significantly at the 5%

REFERENCES

Al- Salhi, K.J.C., 2012. Effect of injection of Japanese quail eggs (Cotwnix Japonica) with testosterone, estrogen and vitamin C hormones in some reproductive, physiological, behavioral and productive characteristics. *PhD thesis, Faculty of Agriculture, University of Basra, Iraq*.

Al-Obeidi, F.A.A.M. 1999. Evaluation of the Qualitative and Chemical Qualities of Japan's Coturnix japonica. PhD thesis, Faculty of Agriculture, University of Baghdad.

Al-Rawi, K.M. and KhalafAllah, A.A.M., 2000. Design and analysis of agricultural experiments. *Second edition, Dar al-Kitab for Printing and Publishing, University of Mosul*, p. 488.

Byron, D.A. (1993). Method for Revitalizing Skin by Applying Topically Water Insoluble *Glucan. United States Patent, 5*, p. 223-491.

Chun, O. K., Kim, D., Smith, N., Schroecter, D. Han, J. T., Lee, C Y. 2005. "Daily consumption of phenolics and total antioxidant capacity from fruit and vegetables in the *American diet''. J. Sci. Food Agric., 85*, p. 1715-1724.

Corredor, D.Y., Salazarc, J.M., Hohnc, K.L., Beand, B., Bean, S. and Wang, D., 2007. Evaluation and Characterization of Forage Sorghum as Feedstock for Fermentable Sugar Production. *Cereal Chem. 84*, p. 61- 66.

El-Sherbiny, D.A., Khalifa, A.E., Attia, A.S., and Eldenshary, E.E.D.S., 2003. Hypericum perforatum extract demonstrates antioxidant properties against elevated rat brain oxidative status induced by amnestic dose of scopolamine. *Pharmacology Biochemistry and Behavior, 76*(3-4), p. 525-533.

Gago, A., Andrea H., Michaela, H., Zuzana P. and Alena B., 2011. Cereal β-glucans and their Significance for the Preparation of Functional Foods – A Review. *Czech J. Food Sci. Vol. 29, No. 1*. P. 1–14.

Grasso, S., Brunton, N. P., Lyng, J. G., Lalor, F., and Monahan, F.J., 2014. Healthy processed meat products–Regulatory, reformulation and consumer challenges. *Trends in Food Science and Technology*, *39*(1), p. 4-17.

Gulcin, I., Oktay, M., Kireşci, E, and Kufrevioglu, O. (2003). Screening of antioxidant and antimicrobial activities of anise. (Pimpinella anisum L.) seed extracts. *Food Chemistry*, *83*, p. 371-382.

Hozova, B., Kuniak, L., Moravckov, P., and Gajdošov, A. (2007). Determination of water-insoluble β-d-glucan in the whole-grain cereals and pseudocereals. Czech J. Food Sci., 25: 316–324.

Hyun, S.J., Sung, K.J., Cho, M.C., Chol, W.A., Yang, Y., Lim, J.S. , and Yoon, D.Y. (2007) . Antitumor Effect of Soluble β-1,3-Glucan from Agrobacterium sp. R259 KCTC 1019. *J. Microbiol. Biotechnol. 17*(9), p. 1513–1520.

Jaehrig, S. C., Rohn, S., Kroh, L. W., Fleischer, L. G., and Kurz, T., 2007. In vitro potential antioxidant activity of (1→ 3), (1→ 6)-β-d-glucan and protein fractions from Saccharomyces cerevisiae cell walls. *J. of agricultural and food chemistry, 55*(12), p. 4710-4716.

Jiang, J., and Xiong, Y.L., 2016. Natural antioxidants as food and feed additives to promote health benefits and quality of meat products: *A review*. *Meat science*, *120*, p. 107-117.

Karreman, R.J., Dague, E., Gaboriaud, F., Quiles,F. , Duval J.F. , and Lindsey, G.G., 2006. Th stress response protein Hsp12p increase the flexibility of the yeast Saccharomyces cerevisiae. *Biochim. Biophys. Acta. 1436*, p. 239-246.

Kayali, H., Ozdag, M. F., Kahraman, S., Aydin, A., Gonul, E., Sayal, A., and Timurkaynak, E., 2005. The antioxidant effect of β-Glucan on oxidative stress status in experimental spinal cord injury in rats. *Neurosurgical review, 28*(4), p. 298-302.

Levie, A., 1970. The meat hands book 1st ed. The AVI Publishing Co. Connecticut west Port.

McCann, M.C, Defernez, M., Urbanowicz, B.R., Tewari, J.C. Langewisch, T., Olek, A., Wells, B., Wilson, R.H., and Carpita, N.C., 2007. Neural Network Analyses of Infrared Spectra for Classifying Cell Wall Architectures. *Plant Physiol., 143*(3), p. 1314-1326.

Mora-Gallego, H., Guàrdia, M. D., Serra, X., Gou, P., and Arnau, J., 2016. Sensory characterisation and consumer acceptability of potassium chloride and sunflower oil addition in small-caliber non-acid fermented sausages with a reduced content of sodium chloride and fat. *Meat science, 112*, p. 9-15.

Morin, L. A., Temelli, F., and McMullen, L., 2002. Physical and Sensory Characteristics of Reduced- Fat Breakfast Sausages Formulated with Barley β- Glucan. *J. of food science, 67*(6), p. 2391-2396.

Nagulendran, K.R.; Velavn, S.; Mahesh, R. and Begum, V.H., 2009. In vitro antioxidant activity and total poly phenolic content Cyperus ratundus Rhizomes. *J. Chem., 4*, p. 440-449.

Naja, G., Mustin, C., Volesky, B., and Berthelin, J., 2005. A high-resolution titrator: a new approach to studying binding sites of microbial biosorbents. *Water research, 39*(4), p. 579-588.

Omana, D. A., Plastow, G., and Betti, M., 2011. Effect of different ingredients on color and oxidative characteristics of high pressure processed chicken breast meat with special emphasis on use of β-glucan as a partial salt replacer. *Innovative food science and emerging technologies*, *12*(3), p. 244-254.

Oyaizu, M., 1986. Studies on products of browning reaction: Ant oxidation activities of products of browning reaction prepared from glucosamine. *Japans J. Nut., 44,* p. 307-315 .

Ozcan, O., and Ertan, F., 2018. Beta-glucan Content, Antioxidant and Antimicrobial Activities of Some Edible Mushroom Species. *Food Science and Technology, 6*(2), p. 47-55.

Pearson, D., Egan, H.; Kirk, R. S. and Sawyer, R., 1981. Chemical analysis of food. *Longman Scientific and Technical New York.*

Resconi, V. C., Keenan, D. F., Barahona, M., Guerrero, L., Kerry, J. P., and Hamill, R. M., 2016. Rice starch and fructo-oligosaccharides as substitutes for phosphate and dextrose in whole muscle cooked hams: Sensory analysis and consumer preferences. *LWT-Food Science and Technology, 66*, p. 284-292.

Santipanichwong, R., and Suphantharika, M., 2009. Influence of different β- glucans on the physical and rheological properties of egg yolk stabilized oil-in-water emulsions. *Food Hydrocolloids, 23*(5), p. 1279-1287.

Shan, L.C., De Brún, A., Henchion, M., Li, C., Murrin, C., Wall, P.G., and Monahan, F.J., 2017. Consumer evaluations of processed meat products reformulated to be healthier–A conjoint analysis study. *Meat science, 131*, p. 82-89

SPSS (2012). Statisical Packages of Social Sciences. Version 15 for windows SPSS. Inc. USA.

Thondre, P.S., Ryan, L., and Henry, C.J.K., 2011. Barley β-glucan extracts as rich sources of polyphenols and antioxidants. *Food Chemistry*, *126*(1), p. 72-77.

Turkoglu, S., Turkoglu, I., Kahyaoglu, M., and Celık, S. 2010. Determination of antimicrobial and antioxidant activities of Turkish endemic Ajuga chamaepitys (L.) Schreber subsp. euphratica PH Davis

(Lamiaceae). *J. of Medicinal Plants Research, 4*(13), p. 1260-1268.

Worrasinchai, S., Suphantharika, M., Pinjai, S., and Jamnong, P., 2006. β-Glucan prepared from spent brewer's yeast as a fat replacer in mayonnaise. Food hydrocolloids, 20(1), p. 68-78.