Original article

A New Investigation on Biological Activities and Potential Health Functions of Royal Jelly on *Saccharomyces cerevisiae*

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Abstract. *Study Objective*: Royal jelly is a bee product that has a nutritious value and has been used in the treatment of many diseases since ancient times. Royal jelly has the ability to scavenge free radicals thanks to its antifungal, antiviral, antimicrobial, anti-inflammatory and antioxidant effects. *Methods*: In this study, four groups were created to investigate whether Royal jelly has a protective role against copper chloride ($CuCl_2$) damage in *Saccharomyces cerevisiae*. Study groups: (1) Control Group: Group in which only yeast was cultivated; (2) $CuCl_2$ Group: The group given $CuCl_2$ (30 mM); (3) Royal jelly Group: The group given Royal jelly (10%); (4) Royal jelly + $CuCl_2$ Group: The group given Royal jelly (10%) + $CuCl_2$ (30 mM). *Saccharomyces cerevisiae* cultures were grown at 30 °C for 1, 3, 5 and 24 hours. Cell growth, GSH (glutathione) levels, CAT (catalase) activities and lipid peroxidation MDA (malondialdehyde) analyzes were determined by spectrophotometer. Total protein concentrations were determined by SDS-PAGE electrophoresis and Lowry protein method. *Results*: When compared with the $CuCl_2$ group, cell growth (1, 3, 5 and 24 hours), total protein synthesis, CAT activities (24 hours) and GSH level (24 hours) increased in Royal jelly groups, while MDA level (24 hours) decreased. *Conclusions*: Thanks to the antioxidant properties of Royal jelly, it has been determined that it increases cell growth and total protein synthesis by reducing oxidative stress in *Saccharomyces cerevisiae* culture. It has been concluded that these natural products also have strong therapeutic effects in the treatment of many diseases.

Key words: cell growth, electrophoresis, protein synthesis, royal jelly, *Saccharomyces cerevisiae*

Introduction

Beekeeping is a field of agricultural occupation that can be done with a little capital without being tied to the soil, generates income in a short time, provides various bee products and has been given great importance all over the world in recent years. Today, beekeeping is an important animal husbandry branch, albeit for different purposes, in both developed and developing countries. Although honey is the main product in our country's beekeeping, the production and use of products such as Royal jelly and bee pollen is increasing due to its high antioxidant capacity in addition to honey production (1). Royal jelly is a bee product with a high nutritional value and as a result of the 6-17 day young worker bees digesting the pollen and nectar in their digestive organs, Royal jelly is secreted from the mandibular and hypopharyngeal glands on their heads. Royal jelly is a fluid and homogeneous substance with a paste structure. It has a light beige and yellowish white color, pungent phenolic odor and a sour taste. It contains protein, lipid, carbohydrate, ash, P, Na, K, Ca, Mg, pollen, vitamins C, D, E and B vitamins and some other vitamins. The structure of Royal jelly consists of 60-70% water, 12-16% crude protein, 10-16% sugar and 3-6% lipid, vitamin and mineral salts. The composition of Royal jelly may vary depending on the climate and some environmental factors. Royal jelly has many bioactive ingredients. Its main

bioactive component is 10-hydroxy-2-decanoic acid, which is an unsaturated fatty acid and is found only in Royal jelly in nature. Antibacterial, antifungal, antiviral and immune system activating properties of this component have been reported. Royal jelly contains major proteins with a high content of essential amino acids and peptides with immunomodulatory and antioxidant properties. The polyphenols and phenols which it contains are important proteins responsible for antioxidant activity (2,3). Royal jelly has pharmacological properties such as antioxidant, regulating the nervous system, lowering blood sugar and cholesterol, protecting the liver, lowering blood pressure and regulating blood pressure, antitumor, antibiotic, anti-inflammatory, immunomodulating, antiallergic, general tonic and antiaging. Because of these properties, Royal jelly is a commercial product in many countries and is widely used in medical products, foods and cosmetics (4). *Saccharomyces cerevisiae* (*S. cerevisiae*) cells are immobile, relatively small oval spheres approximately 10 μm long and 5 μm wide. However, their size may vary even within the same strain of a particular species due to environmental conditions. Average cell volumes depend on whether the cell genome is haploid or diploid. In addition, the size of a yeast cell is directly proportional to its age. *S. cerevisiae* can be easily cultured in solid or liquid media containing essential nutrients. If the nutrients in the environment are sufficient, they can grow as fast as bacteria. *S. cerevisiae* has 16 chromosomes. The total genome contains 78.520 nucleotide pairs of mitochondrial DNA and approximately 13.117,000 nucleotide pairs. Due to these genome characteristics, it is thought to be approximately 23% similar to the human genome. Especially in health issues, *S. cerevisiae* is used as a biological control agent. Recombinant DNA technology is of interest to use yeast for the production of therapeutic heterologous proteins. The reason for this is that functional genome analysis of *S. cerevisiae* provides a better understanding of the human genome (5). For this reason, *S. cerevisiae* is used as a model organism in our study. In our study, the negative effects of copper chloride ($CuCl_2$), which we used to cause damage, were determined by the oxidative stress indicator malondialdehyde (MDA), while the protective effects of Royal jelly we used for treatment were determined by the antioxidant defense enzyme systems glutathione (GSH) and catalase (CAT) activity. Among these analyzes, malondialdehyde (MDA) is a product resulting from the interaction of reactive oxygen species with cellular membranes and is a marker of membrane lipid peroxidation. By causing membrane damage, it causes disruption of cellular homeostasis by changing membrane characteristics. The most vital defense against peroxidative damage of biological membranes in mammalian cells is the antioxidant enzyme system. Among these enzymes, glutathione (GSH), it is the enzyme responsible for the reduction of hydroperoxides. The membrane catalyzes the breakdown of hydrogen peroxide (H_2O_2) and lipid peroxides by reduced glutathione by reducing its phospholipids and hydroperoxides to alcohols. Thus, it protects membrane lipids and hemoglobin against oxidation of peroxides. Catalase (CAT) enzyme provides effective protection by destroying hydrogen peroxide formed by oxidase effect (6). In this study, damage was created by applying copper chloride ($CuCl_2$) to *S. cerevisiae* culture and the protective effects of Royal jelly were investigated by biochemical and molecular biology analyzes against *S. cerevisiae* cell growth.

Materials and methods

Research groups

4 groups were formed in this study. Research groups:

1. Control group: Group in which only yeast was cultivated;
2. $CuCl_2$ group: The group given $CuCl_2$ (30 mM);
3. Royal jelly group: The group given Royal jelly (10%);
4. Royal jelly + $CuCl_2$ group: The group given Royal jelly (10%) + $CuCl_2$ (30 mM).

After sterilization, Royal jelly and $CuCl_2$ were added to the cultures of *S. cerevisiae* in certain cases. Cultures growth at 30 °C for 1 hour, 3 hours, 5 hours and 24 hours (overnight). Growth medium of *S.cerevisiae*: YEPD (for 50 mL; 1.5 g yeast extract, 1.5 g tryptone, 1.5 g glucose) was added to the solution for the growth and propagation of *S. cerevisiae* and developed (7).

Royal jelly and $CuCl_2$ chemical application to S. cerevisiae culture

Royal jelly (10%) + $CuCl_2$ (30 mM) was added to *S. cerevisiae* medium and developed at 30 °C. Royal jelly + $CuCl_2$ Group: Royal jelly (10%) + $CuCl_2$ (30 mM) was added to the recording.

S. cerevisiae cell growth measurements

The developed cultures samples were grown at 30 °C for 1, 3, 5 and 24 hours (overnight) and measurements were made at 600 nm wavelength with spectrophotometer.

S. cerevisiae total protein density (lowry) measurements

Total protein changes in the groups were carried out according to the Lowry protein assay kit method by measuring the spectrophotometer at 650 nm. (3,7).

S. cerevisiae malondialdehyde (MDA)analysis

The amount of lipid peroxidation was measured according to the query of thiobarbituric acid reagent types. The amount of malondialdehyde (MDA) is indicated as an indicator of lipid peroxidation. Following the sample, one volume and two volumes of the stock solution (0.25 N HCl 0.375% thiobarbituric acid and 15% trichloroacetic acid) were mixed in the centrifuge tube. The solution was heated in boiling water for 15 minutes and cooled. The precipitate was centrifuged at 2500 rpm for 10 minutes and the supernatant sample was read at 532 nm wavelength in the spectrophotometer and the results were reported as nmol/ml (8).

S. cerevisiae glutathione (GSH) analysis

Samples taken for glutathione analysis were precipitated with 50% trichloracetic acid (TCA) and centrifuged at 1000 rpm for 5 minutes. Taking 0.5 ml of the supernatant, which is the supernatant of the precipitated sample, 2 ml of Tris-EDTA buffer (0.2 M, pH = 8.9) and 0.1 ml of 0.01 M 5.5'-dithio-bis-2 -nitrobenzoic acid was added. This mixture was left at room temperature for 5 minutes and its absorbance was measured at 412 nm in a spectrophotometer. Results were stated as µg/ml (8).

S. cerevisiae catalase (CAT) activity determination

0.2 ml of samples were taken from the cultures and incubated in 1.0 ml of substrate at pH: 7 in 50 mM phosphate buffer (containing 65 micromoles H_2O_2 in each millimeter) at 37 °C for 60 seconds. The sample was measured at a wavelength of 405 nm in a spectrophotometer against to blank. The absorbance change of H_2O_2 was read for 1 minute and the values were determined as U/ml catalase activity (8).

S. cerevisiae SDS- PAGE (sodium dodecyl sulfate-polyacrylamide gel electrophoresis) analysis

Samples of *S. cerevisiae* cultures were prepared for SDS-PAGE. Protein samples for electrophoresis were stained with sample application buffer. Equal amounts of the stained protein samples were taken and loaded into the electrophoresis gel slots. The movement of the bands in the gel was provided by applying an electric current. Then, these bands were stained with coomassie blue. Proteins were then analyzed by SDS PAGE. Protein bands which between gel groups were examined (7).

Statistical Analysis

The statistical analysis of the study was evaluated with the analysis of variance in the SPSS 22 package program. One Way Anova *Post Hoc* Tukey and LSD tests were applied in at least 3 repetitions to ensure the reliability of the differences within the groups.

Results

S. cerevisiae cell development measurement results

According to Figure 1A, there was a significant difference between the groups with different development times ($p < 0.05$). Royal jelly increased cell growth in Royal jelly and Royal jelly + $CuCl_2$ groups in comparison to the $CuCl_2$ damage group.

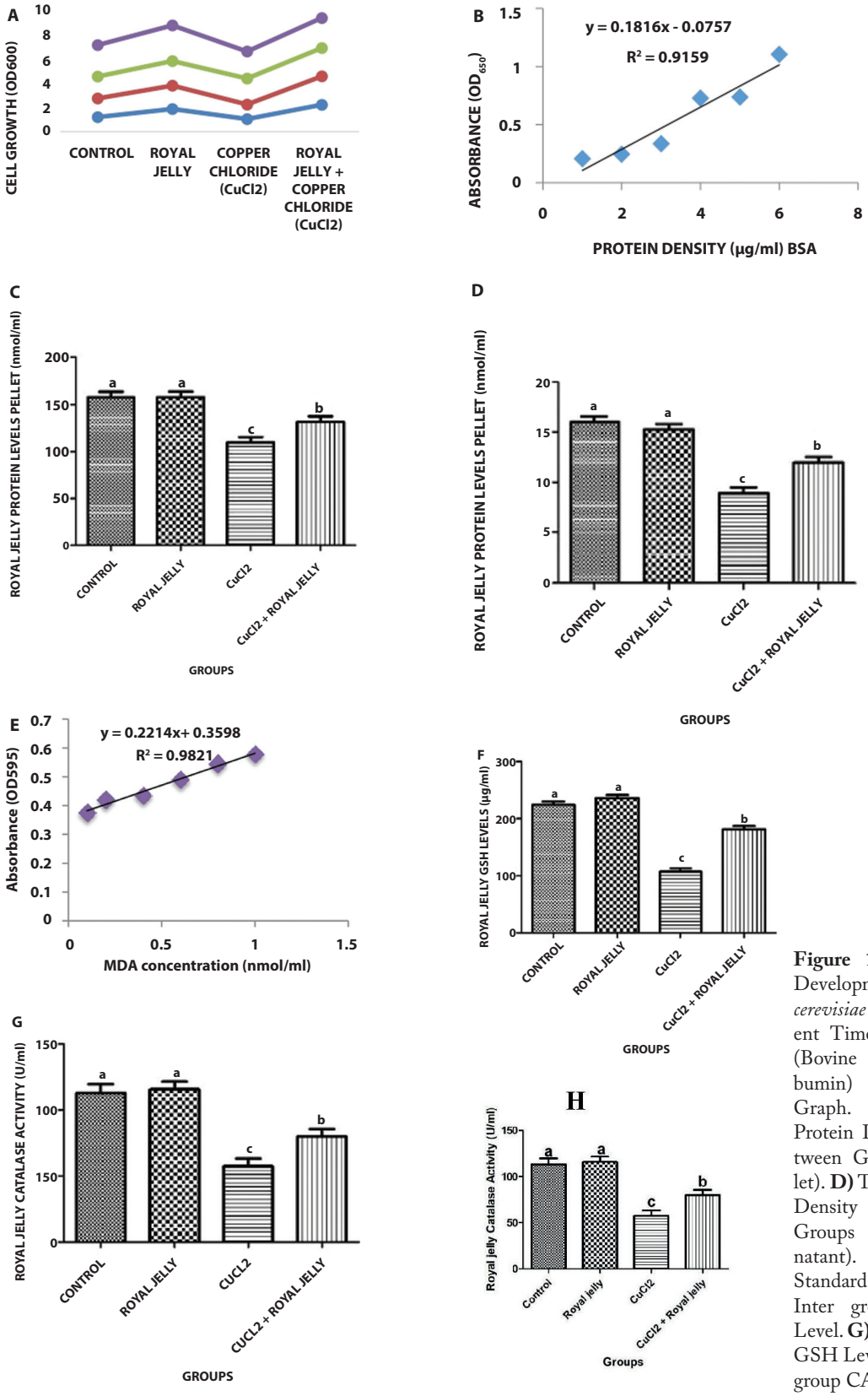

Figure 1. A) Cell Development of *S. cerevisiae* at Different Times. **B)** BSA (Bovine Serum Albumin) Standart Graph. **C)** Total Protein Density Between Groups (Pellet). **D)** Total Protein Density Between Groups (Supernatant). **E)** MDA Standard Curve. **F)** Inter group MDA Level. **G)** Inter group GSH Level. **H)** Inter group CAT Level

S. cerevisiae total protein density (lowry) measurements

When the total protein results in Table 1, 2, 3, Figure 1B, Figure 1C and Figure 1D were examined, we can say that Royal jelly promotes protein synthesis in *S. cerevisiae*. Especially when compared with the $CuCl_2$ group, it was seen that the protein synthesis increased at a high rate in the Royal jelly + $CuCl_2$ group.

S. cerevisiae malondialdehyde (MDA) analysis results

Table 4 and Figure 1E,F reveals that the highest MDA levels were in $CuCl_2$ group and significantly decreased in Royal jelly + $CuCl_2$ group ($p<0.05$).

Table 1. Total Protein Densities of Pellet

Groups (Pellet)	Total Protein Density (nmol/ml)
Control	158.23 ± 0.20^{a}
Royal jelly	158.47 ± 0.22^{a}
Copper chloride ($CuCl_2$)	110.02 ± 0.11^{c}
Royal jelly + Copper chloride ($CuCl_2$)	132.13 ± 0.17^{b}

[a-c]: *The difference between the groups bearing the different letters in the columns is significant ($p<0.05$).*
One-Way ANOVA Post Hoc LSD Test

Table 2. Total Protein Densities of Supernatant

Groups (Supernatant)	Total Protein Density (nmol/ml)
Control	16.00 ± 0.03^{a}
Royal jelly	15.25 ± 0.03^{a}
Copper chloride ($CuCl_2$)	8.89 ± 0.01^{c}
Royal jelly + Copper chloride ($CuCl_2$)	11.94 ± 0.02^{b}

[a-c]: *Among the groups which bearing of different letter are significant ($p<0.05$).*
One-Way ANOVA Post Hoc LSD Test

S. cerevisiae glutathione (GSH) analysis

When we examine the GSH levels given in Table 5 and Figure 1G, the lowest GSH level was in the $CuCl_2$ group and decreased significantly in Royal Jelly + $CuCl_2$ group ($p<0.05$).

S. cerevisiae catalase (CAT) activity determination

When we examined the CAT levels given in Table 6 and Figure 1H, the lowest CAT level was in the $CuCl_2$ group and decreased significantly in Royal jelly + $CuCl_2$ group ($p<0.05$).

S. cerevisiae SDS-PAGE (sodium dodecyl sulfate-polyacrylamide gel electrophoresis) analysis

The SDS-PAGE gel image (Figure 2A, 2B, 2C, 2D) showed that the protein concentration was significantly increased in Royal Jelly + $CuCl_2$ group when compared to the $CuCl_2$ group. As a result of this study, it was concluded that Royal jelly increases the development of *S. cerevisiae* despite the negative effects of $CuCl_2$.

Discussion

As a result of scientific studies of Royal jelly in the discovery began to be consumed by humans that has a rich content plays a major role. Along with its antioxidant properties, Royal jelly is mostly used as a strengthening supplement due to its share in cell development and protection in bees. In addition, Royal jelly offers unique solutions due to its benefits such as preventing cancer types, regulating blood pressure and cholesterol, treating infertility, improving digestive disorders

Table 3. Cell Development of *S. cerevisiae* in Royal jelly at Different Times

Groups	1h	3h	5h	24h(Overnight)
Control	1.21 ± 0.02^{d}	1.54 ± 0.03^{c}	1.80 ± 0.04^{b}	2.59 ± 0.04^{a}
Royal jelly	1.87 ± 0.03^{d}	1.92 ± 0.04^{c}	2.02 ± 0.04^{b}	2.94 ± 0.05^{a}
Copper chloride ($CuCl_2$)	1.04 ± 0.01^{d}	1.20 ± 0.02^{c}	2.14 ± 0.01^{b}	2.23 ± 0.02^{a}
Royal jelly + Copper chloride ($CuCl_2$)	2.22 ± 0.02^{d}	2.35 ± 0.03^{c}	2.33 ± 0.02^{b}	2.48 ± 0.03^{a}

[*a,b,c,d]: *The difference between the groups with different letter are significant ($p<0.05$).*
One-Way ANOVA Post Hoc LSD Test

Table 4. MDA Level (Pellet)

Groups	MDA Levels (nmol/ml)
Control	5.11 ± 0.20[c]
Royal jelly	5.26 ± 0.20[c]
Copper chloride ($CuCl_2$)	6.97 ± 0.23[a]
Royal jelly + Copper chloride ($CuCl_2$)	6.51 ± 0.17[b]

[a-c:] *Among the groups which bearing of different letter are significant (p<0.05).*
One-Way Anova Post Hoc LSD Test

Table 5. GSH Level (Pellet)

Groups	GSH Levels (µg/ml)
Control	224.11 ± 0.20[a]
Royal jelly	235.88 ± 0.23[a]
Copper chloride ($CuCl_2$)	107.11 ± 0.12[c]
Royal jelly + Copper chloride ($CuCl_2$)	181.47 ± 0.17[b]

[a-c:] *Among the groups which bearing of different letter are significant (p<0.05).*
One-Way Anova Post Hoc LSD Test

Table 6. CAT Level (Pellet)

Groups	CAT Activity (U/ml)
Control	112.88 ± 0.35[a]
Royal jelly	115.79 ± 0.36[a]
Copper chloride ($CuCl_2$)	57.41 ± 0.20[c]
Royal jelly + Copper chloride ($CuCl_2$)	79.91 ± 0.30[b]

[a-c:] *Among the groups which bearing of different letter are significant (p<0.05).*
One-Way Anova Post Hoc LSD test

and preventing premature aging. Due to these unique solution possibilities, it attracts great attention in the cosmetics sector as well as the health and food sectors (1). Aslan et al. (7) investigated the protective roles of tomatoes against H_2O_2 induced damage in *S. cerevisiae* and they found that tomatoes have a protective feature thanks to their antioxidant properties. Aslan et al. (9) stated that grape seed reduces the oxidative stress damage caused by H_2O_2 in *S. cerevisiae* and it has a protective role on the growth of *S. cerevisiae*. In addition, they found that the MDA level increased in the H_2O_2 groups. Babele et al. (10) found that zinc oxide nanoparticles induced toxicity in *S. cerevisiae* by affecting cell wall integrity and lipid homeostasis. Beyaz et al. (11) investigated the protective effects of black mulberry (*Morus nigra* L.) and cranberry (*Cornus mas* L.) fruits on H_2O_2 induced oxidative stress in *S. cerevisiae* and they concluded that black mulberry and cranberry fruits have a very strong therapeutic effect against oxidative stress. In addition, they stated that MDA level decreased and total protein level increased significantly in the groups given black mulberry and cranberry extracts compared to the H_2O_2 added groups. Aslan (12) emphasized that different juices and their combinations have a protective role in reducing oxidative damage and increasing cell growth in *S. cerevisiae*. Albuz (13) investigated the cytotoxic effects of ginger, turmeric and clove, which are used as food supplements in daily life. He stated that the cytotoxic effect of ginger and turmeric is negligible especially for normal cells and these two herbs have a strong antioxidant effect. Huang et al. (14) investigated the effects of OLE1 on oxidative stress due to cadmium in *S. cerevisiae* and they stated that OLE1 reduced oxidative stress caused by cadmium thanks to its antioxidant properties. Vazquez et al. (15) stated that melatonin reduced oxidative stress damage caused by hydrogen peroxide in *S. cerevisiae*. Aslan et al. (3) stated that kiwi extract increases cell growth by reducing oxidative damage *in S. cerevisiae* thanks to its antioxidant properties. Aslan (16) stated that mulberry extract increased cell growth by providing significant protection against H_2O_2 damage in *S. cerevisiae*. Almeer et al. (17) aimed to evaluate the potential neuroprotective effect of Royal jelly (RJ) against neuronal damage caused by cadmium (Cd). They found that MDA level and Bcl-2 protein expression decreased, CAT activity and caspase-3, Bax and Nrf-2 protein expression significantly increased in Royal jelly applied groups. In addition, they found that Royal jelly provides neuroprotective protection against damage to cortical neurons, thanks to its antioxidant properties. Mohamed et al. (18) aimed to assess the possible neurotoxic effect of tartrazine (T), a widely used synthetic azo dye, as well as to identify the potential regulatory role of cod liver oil (CLO) and Royal jelly against such effects. The groups treated with tartrazine

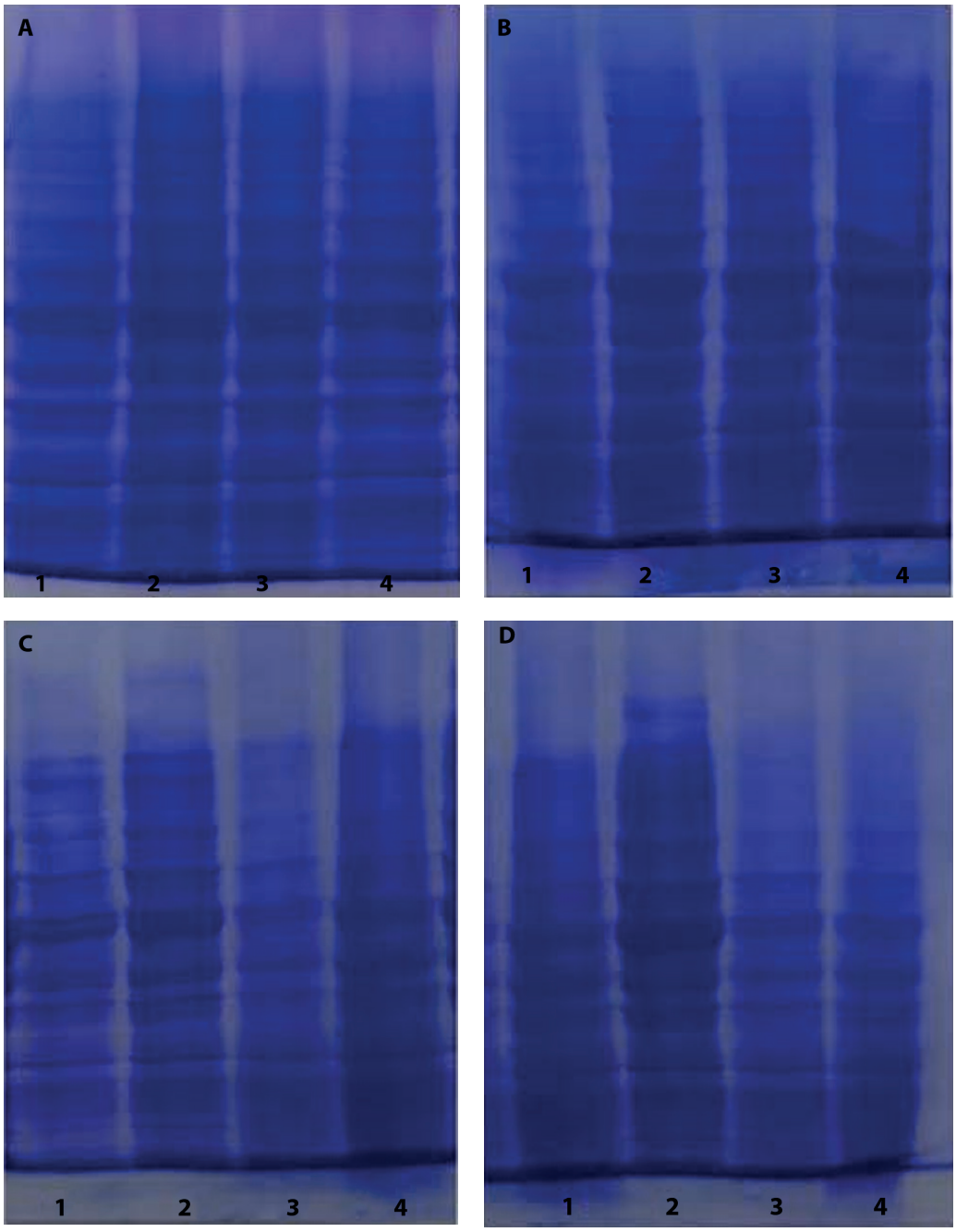

Figure 2. A) SDS-PAGE Pellet Protein Bands (1h). Bands 1: Control; 2: Royal jelly; 3: $CuCl_2$; 4: Royal jelly + $CuCl_2$. **B)** SDS-PAGE Pellet Protein Bands (3h). Bands 1: Control; 2: Royal jelly; 3: $CuCl_2$; 4: Royal jelly + $CuCl_2$. **C)** SDS-PAGE Pellet Protein Bands (5h). Bands 1: Control; 2: Royal jelly; 3: $CuCl_2$; 4: Royal jelly + $CuCl_2$. **D)** SDS-PAGE Pellet Protein Bands (24h). Bands 1: Control; 2: Royal jelly; 3: $CuCl_2$; 4: Royal jelly + $CuCl_2$

showed a significant decrease in the concentration of brain neurotransmitters and the levels of antioxidant biomarkers (CAT, GSH), while a significant increase in MDA levels was observed. When all parameters are taken into consideration, it was determined that CAT activity and GSH level increased in both T + RJ and T + CLO groups, and there was a significant decrease in MDA levels compared to the T group. These results

show that RJ and CLO application provides effective protection on T induced brain tissue damage and destructive effects in rat pups. Almeer et al. (19) stated that Royal jelly administration in cadmium-derived mice provided effective protection against nephrotoxicity by preventing inflammation and apoptosis. They stated that MDA level, Bcl-2, NF-κB and TNF-alpha protein expression decreased, GSH level and CAT activity as well as caspase-3, Bax and Nrf-2 protein expression increased significantly in cadmium applied groups compared to Royal jelly applied groups. Salahshoor et al. (20) evaluated the anti-inflammatory and protective effects of Royal jelly against kidney disorders caused by ischemia/reperfusion (I/R), which is one of the main challenges in acute kidney injury. They stated that MDA level and TNF-alpha protein expression decreased in Royal jelly applied groups. Volarevic et al. (21) concluded that oxidative stress and TNF-alpha and Bcl-2 protein expression were significantly reduced in groups given Royal jelly against cisplatin-induced nephrotoxicity in rats. In addition, they found that the levels of MDA and Bcl-2 protein expression decreased and Bax and caspase-3 protein expression increased significantly in the groups treated with Royal jelly, unlike the cisplatin applied groups. In addition, when histological results were examined, they observed that the damage to kidney tissue treated with Royal jelly was less. Ohashi et al. (22) investigated the potential effect of adenosine N1-oxide (ANO) contained in Royal jelly for the treatment of inflammatory disorders and found that ANO treatment reduced Gsk-3 and NF-κB protein expression. Jamnik et al. (23) investigated the protective effects of Royal jelly treatment in *S. cerevisiae.* They stated that Royal jelly reduces intracellular oxidation in a dose-dependent manner and positively affects growth and metabolic energy activity in the cell, depending on the growth phase. Additionally, they found that Royal jelly acts as a scavenger of reactive oxygen species in the cell, increasing protein expression.

Soylu (24) obtained a functional product using honey, Royal jelly, propolis, echinacea and yarrow herbs, and the physicochemical, biochemical and antimicrobial properties of this product in *S. cerevisiae* were determined. The product obtained has been found to have a nutrient-rich content and its antioxidant capacity has been found to be quite high. Yavaş (25) investigated the effect of Royal jelly on hormonal and histopathological changes in seminiferous tubules and leydig cells, using the antioxidant and blood glucose homeostasis properties of Royal jelly in diabetic individuals. As a result, he stated that Royal jelly has a protective effect on male infertility caused by diabetes. Zorer (26) examined the stereological effects of the changes in oxidative stress, genotoxicity and apoptosis of Royal jelly treatment against the damage caused by ultraviolet B (UVB). As a result of this study, it was revealed that treatment with Royal jelly reduces the damage caused by UVB thanks to its antioxidant properties. Kaynar (27) investigated whether Royal jelly application had a protective or reducing effect on the table of methotrexate (MTK) induced mucositis in rats. The results obtained have determined that Royal jelly application has a suppressive effect by reducing oxidative stress and lipid peroxidation caused by MTX. Saral (28) investigated the bioactive properties of apitropic bee products (honey, pollen, propolis and Royal jelly) and their roles in preventing liver damage against carbontetra chloride (CCl_4) induced liver damage. He stated that MDA levels increased and CAT activities decreased in CCl_4 applied groups compared to the bee products applied groups. It has been determined that the treatment of bee products such as honey, pollen, propolis and Royal jelly provides effective protection against damage by reducing the effect of toxic agents in the liver. Atabay (29) investigated the effect of Royal jelly treatment on fertility in sheep and he stated that Royal jelly application had positive effects on estrus and fertility. Aslan et al. (30) has been investigated the therapeutic potential of ellagic acid (EA) against damage to pancreatic tissue caused by carbon tetrachloride (CCl_4). They stated that MDA level, Bcl-2 and NF-κB protein expression decreased, GSH level and CAT activity as well as caspase-3 and Nrf-2 protein expression increased in CCl_4 applied groups compared to EA applied groups. Aslan et al. (31) evaluated the effects of EA on antioxidative and anti-inflammation pathways against CCl_4-induced kidney damage in rats. It was concluded that it significantly increased caspase-3 and Nrf-2 protein expression by decreasing NF-κB, VEGF, COX-2 and TNF-alpha protein expression, as well as renal tissue damage in EA-treated groups. When examined in terms of biochemical analysis, they stated that the

groups treated with EA decreased MDA levels and significantly increased GSH levels and CAT activities. Aslan and Can (32) found that grapefruit increased cell growth by reducing oxidative damage in *S.cerevisiae* culture. Aslan and Can (33) stated that in *S. cerevisiae* culture, orange juice increased cell growth by providing highly effective protection against H_2O_2-induced oxidiative stress. Aslan et al. (34) indicated that milk thistle inhibit liver DNA damage in carbontetrachloride-induced liver damage in rats. Aslan and Can (35) emphased that lemon juice protects *S. cerevisiae* against oxidative damage. Aslan et al. (36) point out that Black cumin preserve *S. cerevisiae* against to lung damage.

Conclusion

Increasing the use of bee products as food supplements in traditional medical practices and in terms of human health increases the need for Royal

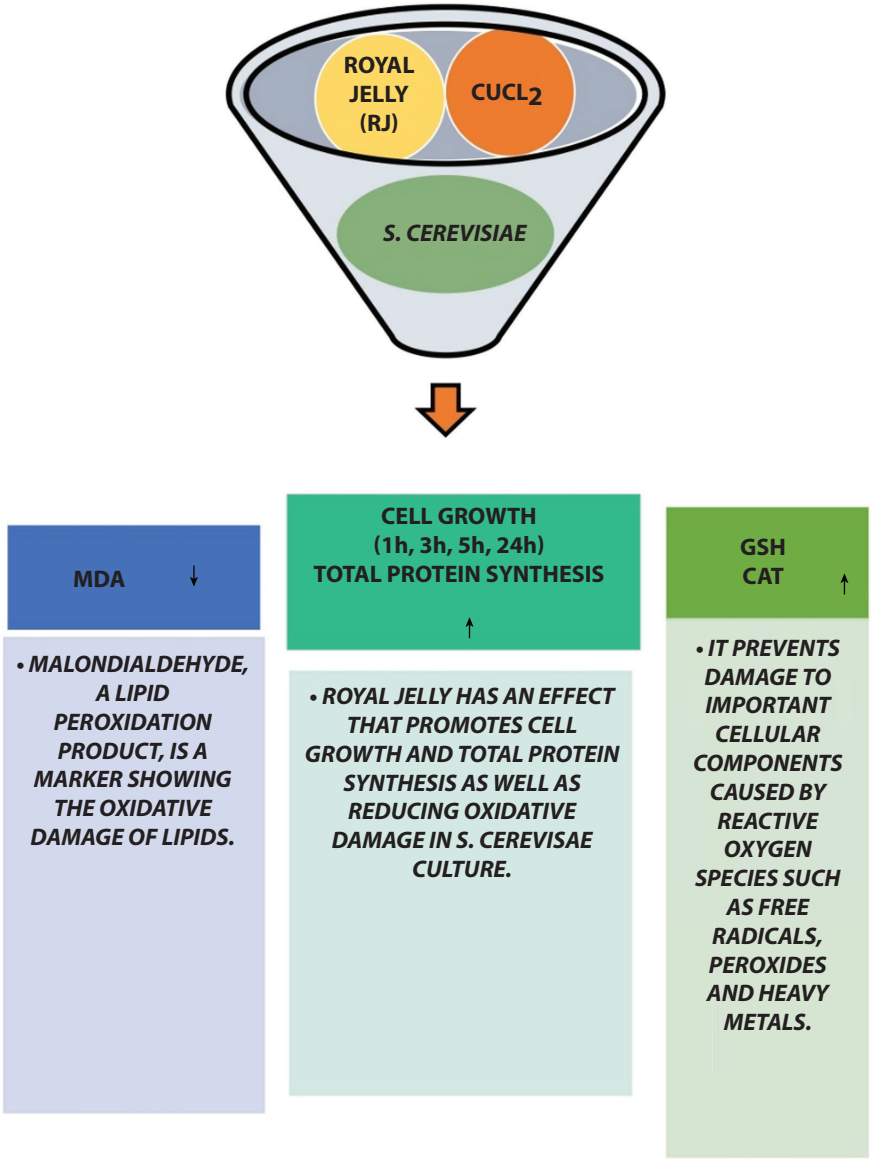

Figure 3. Protective Effect of Royal Jelly on Oxidative Damage

jelly. Bee products have anti-tumor antibiotics, anti-inflammatory, anticancer, antidiabetic, antiallergic and antiaging as in many other countries that have many pharmacological properties, such as, in our country, medical products, foods and cosmetics has increased in common use. As a result of the experimental analysis, it has been determined that Royal jelly treatment provides very strong protection against damage by eliminating the oxidative damage caused by copper chloride in *S. cerevisiae*. When the results of biochemical and molecular biological analyzes were examined, we can say that Royal jelly application promotes total protein synthesis, increases cell growth, and protects the cell against oxidative damage (Figure 3).

Conflicts of interest: There is no conflict of interest between the authors.

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