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The antioxidant activity and the nutritional values of the tahini marmalade

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Abstract
As known, the tahini is a multifunctional nutrient that strengthens the brain and immune system, reduces swelling by protecting heart health, and has the ability to treat asthma diseases. It also increases bone density as it contains various minerals such as copper, phosphor and calcium.
In this study, the tahini was used as the main ingredient, and the honey, propolis, pollen, royal jelly and sesame were used to obtain an untested product with high nutritional. The ash, moisture, % antioxidant activity, protein-carbohydrate-fat analysis, refractive index, the acidity and pH analysis of the obtained nutritive product were performed. In addition, the sensory analysis was evaluated on 15 people for the parameters such as the appearance, clarity, odor, taste and general acceptance. According to the obtained results, it was determined that the bioactive materials added to the final product significantly improved the % antioxidant activity. In addition, the results of the sensory analysis showed that the level of taste was high.
Keywords: *Tahini, honey, bee pollen, propolis, royal jelly, sesame*

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I. INTRODUCTION

The tahini is a very valuable nutrient with unique color, taste and odor. The tahini has excellent nutritional values and supports several health benefits such as improves heart and bone health, reduces chronic diseases and prevents cancer. According to the Sesame Communique, sesame is defined as the dried form of plant seeds of *Esamum indicum* L. *(Pedaliaceae)* species in accordance with the technique. The most people who have recently adopted a healthy lifestyle tend to use natural products as supplements and complementary medicine or alternative treatments (Zaid et al., 2021). The honey is a natural product that has been used as a complementary medicine since ancient times (Lan Nguyen et al., 2019) as it has therapeutic values due to the presence of high nutritional and bioactive components (Dzugan et al., 2018; Zaid et al., 2021).

The biologically active compounds in the honey are investigated into two groups as antibacterial and antioxidants. The polyphenol compounds (phenolic acids and flavonoids), vitamin C, vitamin E and enzymes (for example, catalase, peroxidase) are responsible for the antioxidant activity of honey. According to the Honey Communiqué, reference values of flower honey should be within the limit values given in the explanation (the moisture: 20%, sucrose: 5 g/100 g, fructose + glucose: 60 g/100 g, fructose/glucose: 0.9-1.4, water-insoluble matter: 0.1 g/100 g, the free acidity: 50 meq/kg, the electrical conductivity: 0.8 mS/cm, diastase number: 8, HMF: 40 mg/kg, proline: 300 mg/kg).

The propolis is a resinous and sticky natural complex matrix produced by honey bees from mucilage and sap collected from different regional and botanical sources (plant leaves, flower buds, bark, etc.) (Abbasi et al., 2018). The pollen, which is found in the heads of the male reproductive organs of plants, is one of the important food sources of honey bees. The royal jelly, known as superfood, is the food that is secreted from the upper jaw and pharyngeal salivary glands of 5-15 days old worker bees, and that the queen bees are fed for life (Braakhuis, 2019; Abbasi et al., 2018; Nguyen et al., 2019; Ramsay et al., 2019).

In this study, an untested product with high nutritional value, compatible with taste and texture was obtained by using tahini as the main component and honey, propolis, pollen, royal jelly and sesame as bioactive components. The ash, moisture, % antioxidant activity, protein-carbohydrate-fat, refractive index, pH and the acidity analysis of the formulated nutrient product were evaluated. In addition, sensory tests of the new formulation on 15 people were characterized according to the appearance, clarity, odor, taste and general acceptance.

1.1. Materials

The functional product obtained contains such as; tahini, honey, propolis, royal jelly, pollen and sesame. The total amount of product was prepared as 25 g. The obtained B1 marmalade contains 80% tahini, 12% honey, 0.7% pollen, 1.4% royal jelly, 1.3% propolis and 4% sesame. The obtained B2 marmalade contains 76% tahini, 16% honey, 0.7% pollen, 1.4% royal jelly, 1.3% propolis and 4% sesame The flower honey was used as honey sample. The final product was stored at +4 ^{o}C for further analysis. In the preparation of the product material, raw material support was received from a private commercial company.

1.2. Methods

The Moisture Analysis: The moisture analysis of the final product was performed according to the literature (Baysal et al., 2022).

The Protein Analysis: The protein analysis of samples was carried out according to the literature (Baysal et al., 2022)

Crude Fat Analysis: The crude fat content of samples was determined according to the Soxhlet method as described in AOAC (2000).

The Ash Content Determination: The ash content analysis of the final product was performed according to the literatüre (Baysal et al., 2022; Soylu et al., 2020).

pH Analysis: The distilled water (12.5 mL) was mixed by adding to the sample (5 g) in the homogenizer. The pH value was measured at 20±2 ^{o}C (Soylu et al., 2020).

The Acidity Determination: The acidity analysis of the final product was carried out according to the literature (Baysal et al., 2022; Soylu et al., 2020).

The Determination of %Antioxidant Activity: The percentage of antioxidant activity (AA%) of each substance was assessed by DPPH free radical assay. The measurement of the DPPH radical scavenging activity was performed according to methodology described by Brand-Williams et al., (1995). The following formula (1) was used for calculations;

$$\%\ DPPH\ radical\ scavenging\ activity = \frac{ABS_{control} - ABS_{sample}}{ABS_{control}} x\ 100 \quad (1)$$

The Sensory Analysis: In this study, two new formulations were developed using the tahini, propolis, bee pollen and royal jelly. For each sample, a sensory analysis test was performed on 15 people. In the sensory analysis, the appearance, clarity, odor, taste, and general acceptance of the samples were scored based on the five points: (5) very good; (4) good; (3) neither good nor poor; (2) poor; (1) very poor.

II. RESULTS AND DISCUSSION

The honey contains more than 180 substances, including many minor components such as carbohydrates (predominantly fructose and glucose), protein, enzymes, amino acids, lipids, water, vitamins, minerals, volatile chemicals, phenolic acids and phytochemicals (flavonoids). It is a supersaturated sugar solution.

The moisture content is very important for honey because high moisture content increases the value of water activity and leads to yeast growth which causes fermentation during storage. If there is less than 17.1% moisture in honey, there will be no microbial growth. If this ratio is between 17.1-20.0%, the product exhibits a stable structure, and if it is above 20.0%, osmophilic yeasts begin to reproduce rapidly. The texture, stability and shelf life of honey; represents free acidity, pH and water activity.

The pH value is one of the important quality parameters of honey, and the pH value affects the shelf life, stability and textural structure of honey. In addition, the pH value in honey is dependent on the ionized acids and minerals in its content, and it affects the growth of microorganisms and properties such as enzymatic reaction. The pH value in the honey content specified in the Turkish Standards Institute Honey Standard has been reported as 3.40-6.10.

2.1. The nutritional values and the chemical analysis

According to the literature, the water content of tahini is between 0.39% and 1.47%. Its ash content ranges 2.60% and 3.70%. The reason for the low amount of ash in the tahini samples is due to the fact that the added sesame shells were peeled. The protein and fat percentages of tahini are around 25% and 46%, respectively. In addition, the refractive index of tahini was found to be around 1.45. (Özcan and Akgül, 1994). The nutritional values of tahini products are high in terms of protein, oil and minerals. The analysis results obtained with the auxiliary components added to tahini in this study are shown in Table 1. The most important part of honey content (95%) is carbohydrates. The amount of carbohydrates in honey creates the properties of honey such as fluidity, moisture absorption, crystallization and energy supply (Ötleş, 1995). The carbohydrates

are known as important energy sources because each g of them provides 4 kcal of energy. These compounds also prevent the occurrence of events such as acidosis and ketosis in the body. The degree of free acidity in honey provides important information about the source of the product, although it has many functional properties.

Table 1. Analysis results of the obtained final products*

ANALYSIS TYPE	B1	B2
MOISTURE content %	>20	>20
PROTEIN content %	27.77	28.01
CARBOHYDRATE %	46.64	49.39
Lipid CONTENT %	25.59	22.60
ASH CONTENT %	0.04	0.059
PH	5.71	5.75
ACIDITY	70 meg/kg	70 meg/kg
REFRACTIVE INDEX	1.3339	1.3343

*All data represent the mean value of two replicates.

2.2. Antioxidant Activity Analysis

The one of the biggest benefits of tahini in terms of general health of the body is its antioxidant properties. Tahini prevents harmful substances from entering the body and removes existing harmful substances from the body due to contains beneficial substances like vitamin C. Therefore, tahini is an important nutrient that protects the body from poisoning and harmful bacteria. Tahini also prevents the development of cancer cells with its antioxidant properties. In addition to its antioxidant properties, another important ingredient in tahini, which is known to support the healthy functioning of the kidneys, is methionine. This substance, which is already produced by the body, should be taken as a supplement from outside the body with certain foods. Because methionine is of great importance in the formation of new blood vessels, healing of wounds in the body, and regeneration of the liver. The antioxidant activity analysis was carried out according to the DPPH method. The analysis results were shown in the Figure 1.

The stock DPPH solution was prepared at 60 µM. Then, the stock solution was diluted for 3 serial solutions. The percentage of DPPH scavenging effect was calculated by equation (1), and the antioxidant activity of samples was determined. As shown in Figure 1, There was a remarkable increase of 87.8% and 73.94% for B1 and B2 samples, respectively. According to the literature, the antioxidant activity of tahini was found as 35% by Khalid et al. (2018). The reason for obtaining high antioxidant activity in this study is that the final products contain pollen, royal jelly, sesame and propolis. According to the analysis results, as the concentration of DPPH solution decreased, the % antioxidant activity was also decreased.

Figure 1. % DPPH radical scavenging activity of B1 and B2 samples in the 60, 30, 15 and µM.

2.3. The Sensory Analysis

As a result of the study, honey, propolis, pollen, royal jelly, as well as tahini and sesame were used as the main ingredients, and a product with a taste and texture in harmony with each other was obtained. By changing the proportions of the resulting product content, it was determined as B1 and B2 samples. The sensory analysis of B1 and B2 samples was performed with a scoring system from 1 to 5. The evaluations obtained according to the results of the sensory analysis were shown in Figure 2 and Table 2.

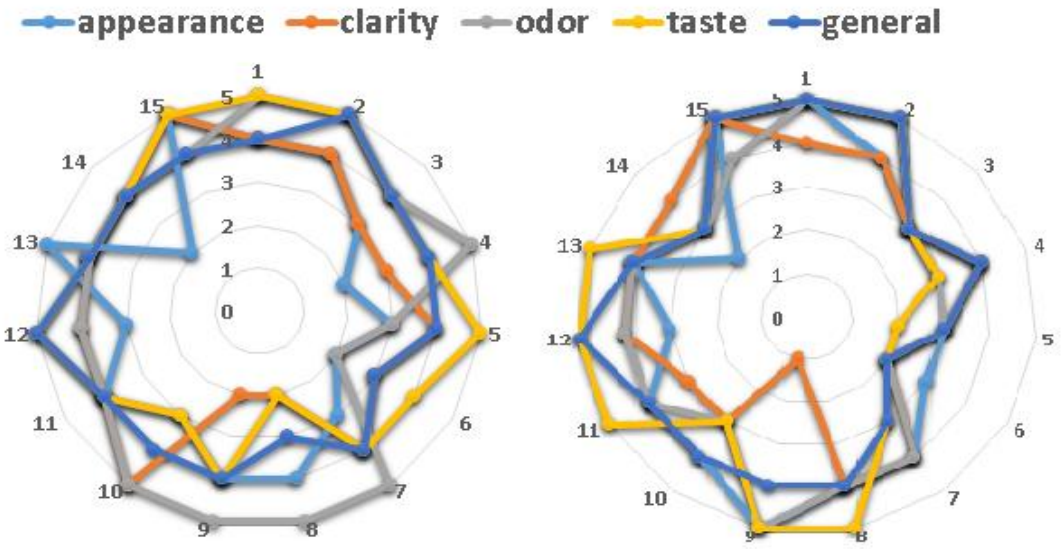

Figure 2. The spider diagram of the sensory analysis

According to the sensory evaluation, the highest score for taste was found in B2 sample; however, B1 sample received the highest score for general acceptance. The sensory characteristic of the tahini products is influenced many factors such as grinding and roasting (Hou et al., 2018). High amount of tahini can give the product a bitter taste which explained the lower score for taste in B1 sample.

Table 2. %The sensory analysis results of B1 and B2 sample.

Individuals	**Very good**		**Good**		**Neither good nor poor**		**Poor**		**Very poor**	
	B1	B2	B1	B2	B1	B2	B1	B2	B1	B2
Appearance	13.3	20	33.3	46.6	33.3	26.6	20	6.6	-	-
Clarity	13.3	6.6	53.3	53.3	20	26.6	13.3	6.6	-	6.6
Odor	33.3	20	53.3	40	6.6	33.3	6.6	6.6	-	-
Taste	33.3	53.3	53.3	-	6.6	33.3	6.6	13.3		
General	13.3	26.6	73.3	40	13.3	26.6	-	6.6	-	-

III. CONCLUSION

Tahini, with the vitamins and minerals helps to prevent certain ailments by increasing the body's resistance. In addition, some substances in Tahini also contribute to a healthier body. Tahini, which strengthens the body's resistance, makes you resistant not only to the flu or cold, but also to very serious diseases such as cancer. Moreover, tahini shows a natural and strong antibiotic effect, so it helps to protect from many ailments. In this study, newly developed formulation of tahini marmalade showed high antioxidant activity and high consumer acceptance. This new product offers a promising nutritious and healthy alternative product to the consumer.

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