Black Sea Journal of Agriculture
doi: 10.47115/bsagriculture.1293710

Open Access Journal
e-ISSN: 2618 – 6578

Research Article
Volume 6 - Issue 5: 452-458 / September 2023

PRODUCT DEVELOPMENT AND SENSORY EVALUATION OF DARK CHOCOLATE FILLED WITH CHESTNUT HONEY

Gamze DOĞAN[1], İlkay YILMAZ[2]*

[1]*Başkent University, Institute of Social Sciences, Department of Gastronomy and Culinary Arts, 06790, Ankara, Türkiye*
[2]*Başkent University, Faculty of Fine Arts, Design and Architecture, Department of Gastronomy and Culinary Arts, 06790, Ankara, Türkiye*

Abstract: Chocolate is a food that people of all ages love to consume. The sensory quality of chocolate is determined by its appearance, taste, aroma, and flavor. Chestnut honey, on the other hand, is a honey that is rich in amino acids, phenolic compounds, flavonoids, tannins, potassium, magnesium, and bioactive substances produced by the pollen of the chestnut tree and flower nectars, it has high antibacterial activity, and it contains important antioxidant compounds. In this study, it is aimed to develop a new product, which was filled with organic chestnut honey and chocolate, and bring it to the market. Chestnut honey was added to chocolate in varying proportions and subjected to quality grading by trained panelists. In the analysis attended by 10 panelists, the quality criteria of appearance, texture, smell, taste, and general acceptance were evaluated under sub-headings. As a result of the analysis, it was determined that the trained panelists gave 4.5±0.67 points out of 5- point scale above the average in terms of general acceptance, and consequently the favorite product was dark chocolate with 7% chestnut honey. In addition, the consumer taste test was applied to a group of 82 people for the filled chocolate with the highest score in the quality rating test. In the test applied depending on the 5-point scale, it was found that the general appreciation was high with the values of 4.75±0.54. As a result of the findings, it was determined that the bitter feeling of chestnut honey in the mouth was perceived in the obtained chocolate, and this was liked by the consumer ($\bar{X}$ = 4.75). With this study, it can be said that chestnut honey and chocolate provide flavor harmony.

Keywords: Chestnut honey, Dark chocolate, Sensory analysis, Product development

***Corresponding author:** Başkent University, Faculty of Fine Arts, Design and Architecture, Department of Gastronomy and Culinary Arts, 06790, Ankara, Türkiye
E mail: ilkayilmaz001@hotmail.com (İ. YILMAZ)
Gamze DOĞAN https://orcid.org/0000-0001-5743-5804
İlkay YILMAZ https://orcid.org/0000-0001-5938-3112

Received: May 08, 2023
Accepted: July 16, 2023
Published: September 01, 2023

Cite as: Doğan G, Yılmaz İ. 2023. Product development and sensory evaluation of dark chocolate filled with chestnut honey. BSJ Agri, 6(5): 452-458.

1. Introduction

Chocolate was first prepared with various spices and flavorings by Aztecs and Mayans and consumed as a beverage. B.C. It is stated in some sources that chocolate drink was consumed in the civilizations before Aztecs in the 2000s B.C. (Sencer et al., 2018).

Chocolate is a delicious product that has a wide appeal for people from all walks of life, and it is consumed with pleasure (Hastaoğlu and Taşçı, 2021). When the annual chocolate consumption amounts per capita worldwide are examined, it has been determined that it is mostly consumed in Switzerland (9kg). In Türkiye, the annual consumption is determined as 3.1 kg per person.

Chocolate is a product prepared by adding cocoa, cocoa butter, sugar, milk powder, and additives (Hastaoğlu and Taşçı, 2021). According to the Turkish Language Association, chocolate means "candy, milk, peanuts, hazelnuts, etc. in cocoa". It is defined as a kind of sweet food made by adding sugar (TDK, 2023). According to the Turkish Food Codex, Cocoa and Chocolate Products Notification (2017/293) chocolate is defined as "it should contain at least 43% total cocoa solids and at least 26% cocoa butter". Dark chocolate is defined as a product consisting of cocoa products and sugar, containing at least 18% cocoa butter, 14% non-fat cocoa solid, and 35% total dry cocoa solids (TGK, 2017).

There are three main types of chocolate as dark, milk and white chocolate, and it can also be diversified as preparing it with permitted additives and flavorings, milk and dairy products and other food ingredients (Seçuk, 2020). In recent years, ruby chocolate has been added to the assortment of chocolate. Ruby chocolate is produced by a company named Callebaut (2017) and its color is pink. The pink color is obtained by developing pigments in the cocoa beans in the chocolate (Young, 2017).

Dark chocolate contains a high amount of cocoa. It has been determined that the dry weight of the cocoa bean contains approximately 50-57% cocoa butter, 15% fibers, 12-18% polyphenols and high amounts of minerals (Kargın and Güneş, 2017). Dark chocolate has organic compounds, especially flavonoids, polyphenols and catechins. It has been determined that these antioxidants prevent oxidative stress that causes heart diseases, diabetes, and cancer diseases by damaging cells and tissues. In addition, flavonols are known with their providing the expansion of blood vessels, balancing blood pressure and accelerating blood flow, as they provide nitric acid production in the body (Koca, 2011). In

addition, it has been determined that dark chocolate improves brain functions thanks to its components, it increases good cholesterol (HDL) by lowering bad cholesterol (LDL), balances insulin, prevents damage to the brain caused by Alzheimer's and Parkinson's diseases, and it is a store of zinc, phosphorus, and potassium (Sarıgül, 2014). According to a study conducted by Djoussé et al. (2011) in the USA evaluating the clinical effects of chocolate on cardiovascular health among 4970 adults aged 25-93 with heart disease, consumption of 28-34 g dark chocolate at least once a week has a negative effect on the progression of coronary heart disease, and it has been found to be a useful nutrient for the right dose of consumption (Djoussé et al, 2011; Kargın and Güneş, 2017).

Chocolate is a nutritious snack that is consumed fondly in many countries around the world. The main quality elements for chocolates are parameters such as taste, texture, smell, appearance and general taste, and the production method, raw materials used, and storage process affect the quality and degree of appreciation of the chocolate.

Chestnut (*Castania sativa*) honey has a strong herbal aroma and this aroma changes depending on the amount of chestnut oil in its content. The taste is slightly bitter, not too sweet. It is dark in color, sometimes with shades of amber, ranging from brown to almost black. The honey is rich in glucose oxidase, catalase, ascorbic acid, carotenoid derivatives, organic acids, amino acids and proteins, phenolic compounds, flavonoids, and minerals such as tannins, potassium, magnesium, manganese, and barium (Dağ et al., 2017). It has been stated in many studies that dark honey is rich in antioxidants that provide high therapeutic properties (Pehlivan, 2023). Türkiye is one of the countries with a high beekeeping size due to its variable geographical features, rich vegetation, and honeybee breeds with economic extracts (Güler and Demir 2005). Various unifloral flower honeys are produced from plant sources such as citrus, heather, cotton, sunflower, chestnut, and linden that bees use as nectar source in different geographical regions of our country (Özkök et al., 2021). Chestnut (*Castanea sativa*) honey is produced in the Black Sea, Marmara, and Aegean regions of Türkiye (Sarıkaya et al., 2009). In different studies on Anatolian chestnut honey, it has been found that it contains antioxidant compounds with high antibacterial activity (Ayvaz et al., 2018; Güneş et al., 2017; Sarıkaya et al., 2009). Chestnut (*Castanea sativa*) honey should contain at least 70% of the pollen of the plant it is named after (TGK, 2020). Chestnut honey has the potential to be a complementary product for protective and therapeutic applications of human health (Güneş, 2021).

It is a special working activity carried out in an area with the aim of being a pioneer in the market, producing an existing product more effectively or by improving it, or that has never been produced, but planned to be produced in the future (Şahin and Arabacı, 2017). Today, depending on the flexible structure of demand, businesses must not only sell, but also produce goods considering customer demands, they must find products suitable for the market, promote and sell them. It requires the co-ordination of production and marketing functions (Karayel, 2010). Businesses that want to stay ahead of the competition and grow in the food sector must closely follow the changes in the environment in which their markets are located, and they must develop strategies suitable for this market. One of the strategies that food businesses can choose to gain competitive advantage in both local and global markets is the new product development strategy (Öztürk and Onurlubaş, 2019). Among the main objectives of the businesses in this sector for developing new products can be listed as producing healthier products that can meet the nutritional needs of consumers at a high level, improving food safety, and offering consumers more product options with high preference. These gains can only be achieved depending on the stable progress of the new product development process. Factors influencing product development in businesses are business policies, marketing opportunities, product characteristics, economic factors, and production possibilities (Kobu, 2013). In the food sector, as in all other sectors, what is essential for the success of the new product is that the new product meets customer expectations (Kuşat and Kösekahyaoğlu, 2011). It will be beneficial for public health to produce foods that contain components beneficial to human health and meet customer expectations. Chocolate is a nutritious snack that is consumed fondly in many countries around the world. The main quality elements for chocolates are parameters such as taste, texture, smell, appearance and general taste, and the production method, raw materials used, and storage process affect the quality and degree of appreciation of the chocolate (Hastaoğlu and Taşçı, 2021). The aim of this study is to develop a dark chocolate product containing organic chestnut honey filling and to evaluate consumer acceptance with a sensory analysis method. In this way, a product containing functional components beneficial to human health will be developed, and products liked by the customer will be determined.

2. Materials and Methods

For ganache filling in chocolate production, drop ivory chocolate with 28% cocoa amount produced by Callebaut Company, Danone Tikveşli Gıda ve İçecek San. Trade Inc. Cream containing 35% animal fat, homemade unsalted butter and organic chestnut honey produced in the city of Düzce, Akçakoca district, were used. The German chocolate company Lubeca Dark Drop chocolate, which has 55% cocoa mass, is used for the outside of the chocolate.

In this study, 3 different recipes containing 5%, 7% and 9% chestnut honey in the following amounts were applied while preparing the ganache filling (Table 1).

First, the cream was taken into a saucepan and brought to the boiling point. Butter and chestnut honey were added to it and mixed. It was taken from the stove and added ivory drop chocolate, and then it melted well, it was homogenized with the help of a blender and left to rest.

Table 1. Recipe of the product developed with 5, 7, 9 % chestnut honey (10 pieces)

Products	(%5)	(%7)	(%9)
Ivory Drop Chocolate	35	33	31
Cream	50	50	50
Butter	10	10	10
Chestnut Honey	5	7	9
Total	100.00	100.00	100.00

2.1. Chocolate Production

Bitter couverture drops are used in making chocolate. Drop chocolate is melted and 12 gr. of it is shaped in a polycarbonate mold. In the melting process of drop chocolate, the bain-marie method is applied in a deep bowl on the water that comes to the boiling point, which is a form of manual tempering. The production was carried out in the Chocolate Workshop within the Baskent University Thermopolium Gastronomy Academy. During the production, attention was paid to ensure that the ambient temperature of the workshop did not exceed 18-20 degrees and the humidity not exceeding 55 degrees.

Before starting the production, the polycarbonate mold was cleaned with ethyl alcohol and cotton. Care was taken with a heat gun that the mold temperature was 25-27 degrees. Dark drop chocolate was melted by the bain-marie method until it reached 40-45 degrees. The melted chocolate was poured on a clean and not wet marble counter and tempered by hand with the help of a pallet and scraper. The tempered chocolate at 30 degrees was filled in a squeezing bag. By squeezing into the polycarbonate mold, the entire mold was filled with chocolate. By hitting the marble counter, the air bubbles were removed (Bardakçı, 2022).

The mold was turned upside down and the extra chocolate was poured onto the counter to form the crust of the chocolate. For the chocolate to have smooth edges, the chocolate remaining in the mold was scraped with the help of a scraper and left to stand at room temperature. The chocolates, which started to cool in the mold, were left to cool in the dehumidification cabinet of +12 °C (Figure 1). Since the mold and ganache temperatures should be close to each other, the ganache filled with chestnut honey to be filled into the crust chocolates was brought to 28-29 degrees with the help of heat gun. The ganache was filled into the shells as 1 mm less than the shell height and left to cool.

Figure 1. Chocolates produced with chestnut honey filling.

It was waited for the cooled mold to reach room temperature, and the tempering steps in shell making were repeated, then the base of the chocolate was made. Extra dark chocolate in the mold was cleaned with a scraper and left to cool in the dehumidifier cabinet of +12 ^{o}C. The mold was turned upside down and the chocolates were removed and stored in the cupboard.

2.2. Sensory Analysis

Sensory analysis is the evaluation of symptoms perceived by people with their senses, and it is a quantitative analysis method (Uçan, 2021). The sensory analysis part of the study was carried out as two stages. In the first part, the quality rating test was applied to 10 trained panelists. In the second stage, the consumer taste test, (hedonic) evaluation test, was applied to 82 people.

As a sensory analysis scale, the characteristics of the panel to be applied were determined with reference to the book "Sensory Evaluation in Foods" by Altuğ-Onoğur and Elmacı (2015). In the sensory analysis panels of 3-10 trained, 8-25 semi-trained, and at least 80 untrained panelists, it was stated that 8-25 semi-trained or at least 80 untrained panelists should be used for hedonic tests (Altuğ-Onoğur and Elmacı, 2015). Panelists were asked to neutralize the remaining taste with water or bread. Twelve statements were questioned under 5 main headings in the first part of study. Chocolates in the quality rating test were evaluated considering appearance; brightness, color; tissue, hardness, chewiness / stickiness, softness, odor/flavour; pleasant odor, unpleasant odor, flavor; Undesirable taste was evaluated in terms of mouthfeel, throat sensation, and post-taste impression parameters. In the consumer taste test, a hedonic scale consisting of five statements was used. The quality criteria of appearance, texture, odor, taste, and general appreciation were evaluated by the panelists. This test also has three questions that describe the participants (age, gender, educational background). In both tests, panelists were asked to rate on a 5-point scale as 1 (I like it a lot), 2 (I like it a little), 3 (I neither like it nor dislike it), 4 (I like it a little) and 5 (I like it a lot).

2.3. Data Analysis

The arithmetic averages of the findings obtained from the sensory analysis were taken, and their standard

deviations were calculated. In addition, descriptive statistics were used in the analysis of the obtained data. Whether the consumer taste test used was affected by gender, age and educational status was determined by the Mann- Whitney U test.

3. Results and Discussion

To determine the reliability of the scales used, Cronbah's Apha value was found to be 0.773. This shows that the scales have internal consistency. At the end of the experiments, the averages and standard deviations of the scores given to the characteristics determined in the sensory analysis applied to the chocolates containing different amounts of chestnut honey are given in Table 2. While the brightness of the product containing 9% chestnut honey was found to be high, its color was also found to be high depending on the appearance features. When the texture properties were compared, it was found that chocolate containing 7% chestnut honey had the best softness and chewiness. The most unfavorable chocolate in terms of softness was found to be the one containing 5% chestnut honey. When the odor and aroma were evaluated, chocolate containing 7% chestnut honey was evaluated as fragrant and without unwanted odor. At this stage, the panelists were asked to give a high score to the product without unpleasant odor. On the other hand, chocolate containing 7% chestnut honey received high scores and became the product with the highest acceptability in the taste criteria in which the undesirable taste, the sensation left in the mouth, the sensation left in the throat and the after-taste impression parameters were evaluated. This result was also reflected in the general taste profile and chocolate containing 7% chestnut honey was found to be the product with the highest general acceptability.

When it is to consider the findings in table 2, it is seen that 9% chestnut honey filled chocolate is high under the appearance criterion, with an average value of 4.9 for the gloss and sensory property, and for the color criterion with an average value of 4.8. Hardness and chewiness /stickiness properties under the texture criterion were higher in 7% chestnut honey filled chocolate, while the softness criterion was higher in 9% chestnut honey filled chocolate with an average value of 4.7. In the odor / aroma criterion, it is seen that the 7% chestnut honey filled chocolate has the highest pleasant odor characteristic of 4.6 and an average value of 4.8 undesirable odor. In the flavor criteria, it is seen that the undesirable taste in the mouth, the sensation left in the throat and the after-taste impression properties achieve the highest average values in 7% chestnut honey filled chocolate. Radar chart of dark chocolate filled with chestnut honey in different proportions is given in Figure 2.

Table 2. Sensory analysis findings on dark chocolate with chestnut honey filling in different proportions

	Sensory properties	5% CH* $\bar{X} \pm SS$	7% CH* $\bar{X} \pm SS$	9% CH* $\bar{X} \pm SS$
Appearance	Brightness	3.9±0.78	4.2±1.08	4.9±0.3
	Color	4±0.67	4.2±0.75	4.8±0.4
Tissue	Hardness	4.1±0.49	4.6±0.66	4.3±0.78
	Chewability / Stickiness	4.1±0.66	4.8±0.40	4.5±0.67
	Softness	4.2±0.46	4.5±0.67	4.7±0.46
Smell	Pleasant smell	4.2±0.46	4.6±0.66	4.1±0.83
	Unpleasant smell	4.2±0.64	4.8±0.40	4.1±0.94
Flavor	Undesirable Taste	3.9±0.8	4.6±0.49	3.9±1.04
	Mouth Feeling	3.8±0.78	4.4±0.66	3.9±0.54
	Throat Sensation	3.7±1.25	4.4±1.20	3.7±1.19
	After Taste Impression	3.8±0.64	4.5±0.67	4.2±0.60
General Acceptability	General Acceptability	3.8±0.64	4.5±0.67	4.0±0.63

Results are given as mean ± standard deviation. $\bar{X} \pm SS$, CH= chestnut honey.

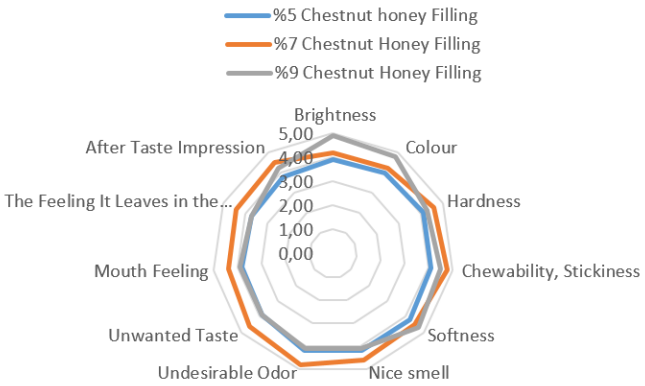

Figure 2. Quality rating test radar chart of dark chocolate with chestnut honey filling in different proportions.

It was determined that the general appreciation criterion was highest in the chocolate filled with 7% chestnut honey with a value of 4.5. It has been determined that the distinctive pungent smell and taste of chestnut honey does not disturb experienced panelists when used at a rate of 7%, and its aroma is appreciated when eaten with chocolate.

As a result of the finding, it was decided to apply the consumer taste test of 7% chestnut honey dark chocolate sample with the participation of 82 people.

3.1. Hedonic Taste Results

The developed product was presented to the consumer taste test, and it was tried to analyze whether the developed product would be accepted by the consumer. For this purpose, considering the quality rating test result, 7% chestnut honey filled dark chocolate was applied to a group of 82 people. The criteria of the hedonic test were determined as appearance, smell, texture, taste and general taste, and then the group consisting of consumers was asked to evaluate.

50% of the panelists participating in the research are men, 50% are women, 35% are graduates, 50% are undergraduates, and 15% are high school graduates. The age range is between 25 and 45.

Considering the factors of gender, age, and educational status in terms of perception of sensory analysis profile in the consumer taste test, it was found that these characteristics of the participants did not affect the result statistically (P>0.05). In Table 3, the mean values with standard deviation of sensory properties of dark chocolate filled with 7% chestnut honey are given. According to the findings, it was seen that the tissue criterion had the highest rate with a mean value of 4.9±0.30. The odor criterion in which the unique smell of chestnut honey is also felt in chocolate achieved the second highest rate with an average value of 4.65. The consumer taste test radar chart is shown in Figure 3.

Table 3. Consumer hedonic test mean and standard deviation values and acceptance rate

Sensory Properties	$\bar{X} \pm SS$*	Acceptance Rate (%)
Appearance	4.60±0.73	92
Smell	4.65±0.65	93
Tissue	4.90±0.30	98
Flavor	4.55±0.80	91
General acceptability	4.75±0.54	95

*Results are given as mean ± standard deviation. $\bar{X} \pm SS$.

When the literature was examined, it was seen that chestnut honey filling was not used for chocolate production in the previous studies. However, when the functional product development studies are reviewed, it is seen that there are chocolate development studies with pomegranate. According to this study, milk chocolate with pomegranate seeds and milk, and white chocolate with pomegranate jelly were evaluated sensorially by 17 volunteer panelists with different tastes and food cultures.

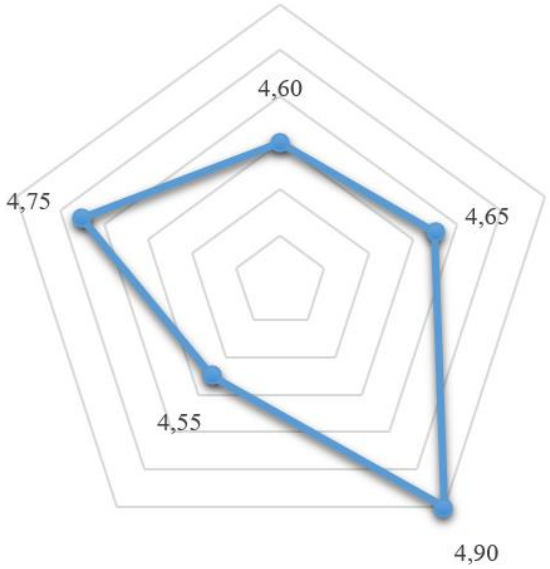

Figure 3. Radar graph of consumer taste test for dark chocolate with 7% chestnut honey filling.

In the sensory evaluation, the color, smell, texture, taste/aroma, and mouthfeel characteristics of the pomegranate chocolates produced were examined, and the scoring was made from 1 to 5, with 5 being the highest. According to the sensory evaluation score made by the panelists, although white chocolate with pomegranate jelly received the highest score in terms of colour, smell and taste/aroma, milk chocolate with pomegranate jelly was the most preferred example in terms of consumption and consumer acceptability. As a result of the evaluations, it has been determined that chocolate with pomegranate is highly appreciated and it will be a preferred product, and the pomegranate chocolates with an average of 17.5% pomegranate seeds or 32.3% pomegranate jelly are more accepted by consumers (Yıldırım et al., 2016). In our study, it is seen that the general taste of chocolate with chestnut honey was appreciated with a score of 4.75 out of 5, which is a score above the average.

In an analysis carried out to be able to predict the chocolate samples with different contents, and to measure their sensory liking by the participants, it was found that smokers among the participants were more successful in detecting the components of chocolate with ingredients such as anise, cardamom or sage (Hastaoğlu, Taşçi, 2021). In our study, smokers were not included in the sensory evaluation. According to another study in which melon, anise, rose, linden, sugar, honey, and sugar flavoring aromas were added to chocolate and evaluated sensorially, it was found that flavoring agents did not have any effect on increasing the perception of sweetness in chocolate formulations (Sencer et al., 2018). Chestnut honey, which was included in our study, did not show any change in the perception of sweetness. A sensory

analysis was carried out in a study in which oatmeal, a functional food rich in dietary fiber and β-glucan, and dried blueberries, which are rich in phenolic substances and contain high antioxidants, were added to chocolate. When the sensory analysis results of the oatmeal and blueberry chocolates were examined, the highest score in terms of "general acceptability" was the control sample, the unadded chocolate, and the lowest score was the chocolate with 40% and 50% added additives. Statistically, the effect of oatmeal and blueberry chocolates on overall acceptability was found to be insignificant (P>0.05) (Üzümcü and Özsisli, 2023). In our study, chocolate containing 7% chestnut honey had the highest results in terms of general acceptability.

4. Conclusion

In this study, a dark chocolate product containing organic chestnut honey filling was developed, and it was presented to the consumer with the sensory analysis method. It was determined that the taste criterion also took the average value of 4.55. According to this result, it is seen that the unique smell and taste of chestnut honey is appreciated by consumers above the average. Appearance criterion, on the other hand, received an average score of 4.60. Here, the panelists stated that they expected a relationship with the image of chestnut honey. It was determined that the general appreciation criterion of the consumer taste test applied to the group consisting of 82 panelists received an average value of 4.75. As a result of the results obtained, it was determined that 7% chestnut honey filled chocolate was the favorite according to the test results on consumers, and a different functional chocolate to consume was obtained. Chocolate is a universally preferred food. With the increasing interest of consumers for products with different contents, their desire to try different products, and the growth of the boutique and industrial chocolate market, products with different contents attract consumers' attention. In this study, the quality rating test of the chocolate, which appeals to people of all ages and from all walks of life and that consumed with pleasure, is diversified and enriched with ingredients in different proportions, and the quality rating test of the components available in it is applied to 10 panelists. As a result of the results obtained, a consumer taste test consisting of 82 people has been conducted. As a result of the sensory analysis carried out in this direction, it was determined that the distinctive sharp smell of chestnut honey and the bitter taste it leaves in the mouth are also quite felt in chocolate. In the evaluation on a scale of 5, it is seen that the general appreciation was appreciated with a score of 4.75 points that was above the average. Chocolate and chocolate products are enjoyed all over the world and in our country. Having considered the additives with functional properties such as chestnut honey, which we use as an additive in our study, and which is rich in phenolic substances, this study and similar ones can be carried out, and the functional property and nutritional quality of chocolate can be increased, thereby positively affecting public health.

The study has shown that chestnut honey-filled dark chocolate will make a great contribution to boutique chocolate producing places, patisseries, hotels, and industrial facility chocolate factories in terms of offering different flavors to consumers and expanding the market area. What is more, it is expected to provide support in terms of introducing a new product to the market. As a result of these results obtained, it has been determined that the product obtained will provide support in terms of bringing it to the market. It can be said that when the bitter taste of chestnut honey is combined with chocolate, it creates a harmonious taste. Recently, one of the popular trends in gastronomy is "Food Pairing", which is a concept translated into our language as 'flavor matching'. This is in fact a method to find out which food will go well with what, and what flavor will emerge as a result. In other words, it can be called the 'art of balanced harmony' between familiar foods. With this study, it can be said that chestnut honey and chocolate provide flavor harmony.

Author Contributions

The percentage of the author(s) contributions is presented below. All authors reviewed and approved the final version of the manuscript.

	G.D.	İ.Y.
C	50	50
D	50	50
S	50	50
DCP	50	50
DAI	50	50
L	50	50
W	50	50
CR	50	50
SR	50	50
PM	50	50
FA	50	50

C=Concept, D= design, S= supervision, DCP= data collection and/or processing, DAI= data analysis and/or interpretation, L= literature search, W= writing, CR= critical review, SR= submission and revision, PM= project management, FA= funding acquisition.

Conflict of Interest

The authors declared that there is no conflict of interest.

Ethical Consideration

Ethics committee approval was not required for this study because of there was no study on animals or humans.

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