SEPTEMBER 2017

M.Sc. in Food Engineering

RIBIN ANWER MAHMOOD

UNIVERSITY OF GAZIANTEP

GRADUATE SCHOOL OF

NATURAL & APPLIED SCIENCES

STANDARDIZATION OF MANNA BAR (LOCAL SWEET) PRODUCTION

M.Sc. THESIS
IN
FOOD ENGINEERING

BY

RIBIN ANWER MAHMOOD

SEPTEMBER 2017

Standardization of Manna Bar (Local Sweet) Production

M.Sc. Thesis

in

Food Engineering

Gaziantep University

Supervisor

Prof. Dr. Hüseyin BOZKURT

by

Ribin Anwer MAHMOOD

SEPTEMBER 2017

REPUBLIC OF TURKEY
UNIVERSITY OF GAZİANTEP
GRADUATE SCHOOL OF
NATURAL & APPLIED SCIENCES
CIVIL ENGINEERING DEPARTMENT

Name of the thesis: Standardization of Manna Bar (Local Sweet) Production.

Name of the student: Ribin Anwer MAHMOOD

Exam date: 8/9/2017

Approval of the Graduate School of Natural and Applied Sciences

Prof. Dr. A. Necmeddin YAZICI
Director

I certify that this thesis satisfies all the requirements as a thesis for the degree of Master of Science.

Prof. Dr. Medeni MASKAN
Head of Department

This is to certify that we have read this thesis and that in our consensus opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Science.

Prof. Dr. Hüseyin BOZKURT
Supervisor

Examining Committee Members:	Signature
Prof. Dr. Sevim KAYA	
Prof. Dr, Hüseyin BOZKURT	
Yrd. Doç. Dr. Ali YILDIRIM	

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Ribin Anwer MAHMOOD

ABSTRACT

STANDARDIZATION OF MANNA BAR (LOCAL SWEET) PRODUCTION

MAHMOOD, Ribin Anwer
M.Sc. in Food Engineering
Supervisor: Prof. Dr. Hüseyin BOZKURT
September 2017
82 pages

Manna bar is a typical Iraqi-Iranian confectionary that made of manna, glucose syrup, sugar, egg white, cardamom and nuts. Manna obtained from leaves and branches of the gallnut and oak trees harvested from the end of May to end of August, depending on the climate of the region. This study was carried out for production of manna bars and investigating the changes in their properties during the production process. The analyses made in this study were moisture content, pH value, color and textural properties, protein, sugar, fat, ash content and sensory analysis. It was found that increasing cooking temperature, cooking and mixing time, and pistachio content decreased ($p<0.05$) moisture content from 15.58% to 5.17%, but increased ($p<0.05$) hardness from 131g to 4451g. Moreover, addition of egg white increased ($p<0.05$) moisture content from 4.84% to 8.97%, but decreased ($p<0.05$) hardness from 1538g to 447g. Increasing pistachio content increased protein, fat and ash contents however decreased sugar content. Increased mixing time and egg white increased the lightness from 67.57 to 86.68. This study showed that high temperature and long cooking and mixing times improved the physical and chemical properties of manna bars. However, the sensory attributes were improved by increasing amount of pistachio as reducing the sweetness value.

Keywords: manna, manna bar, texture, color, cooking and mixing times

ÖZET

KUDRET HELVASI BAR (YÖRESEL TATLI) ÜRETIMININ STANDAR DIZASYONU

MAHMOOD, Ribin Anwer
Gıda Mühendisliği Yüksek Lisans
Danışman: Prof. Dr. Hüseyin BOZKURT
Eylül 2017
82 sayfa

Kudret helvası barı, İrak-İran tipi bir tatlı türü olup, kudret helvası, glikoz şurubu, şeker, yumurta akı ve kakuleden oluşur. Kudret helvası, iklime bağlı olarak Mayis-Ağustos ayları arasında, mazı ve meşe ağaç yaprak ve dallarından toplanır. Bu calışma, kudret helvası barı üretimini standardize etmek ve üretim sırasında değişimleri incelemek için yapıldı. Çalışma kapsamında örneklerin nem, pH değeri, renk ve dokusal özellikleri, protein, şeker, yağ, kül miktarları ve duyusal özellikleri incelendi. Pişirme sıcaklığının, pişirme ve karıştırma süresinin ve antep fıstığı miktarının artması ($p<0.05$) nem miktarını %15,85'den %5,17'ye düşürürken, sertlik değerini 131 g'dan 4451 g'a yükseltti ($p<0.05$). Üstelik yumurta akı eklenmesi nem miktarını %4,84'ten %8,97'ye yükseltirken, sertlik değeri 1538 g'dan 447 g'a düştü. Antep fıstığı miktarının artması protein, yağ ve kül miktarını arttırdı, fakat şeker miktarını düşürdü. Karıştırma süresi ve yumurta akının artması, parlaklık değerini 67,57'den 86,68'e arttırdı. Bu çalışma, yüksek sıcaklık, uzun pişirme ve karıştırma sürelerinin kudret helvası barının fiziksel ve kimyasal özelliklerini geliştirdiğini gösterdi. Buna ragmen, antepfıstığı miktarının artması ürünün tatlılık seviyesini düşürdüğünden duyusal özelliklerini geliştirdiği belirlendi.

Anahtar kelimeler: kudret helvası, kudret helvası barı, doku, renk, pişirme ve karıştırma süreleri

ACKNOWLEDGMENT

I express sincere appreciation to my supervisor Prof. Dr. Hüseyin BOZKURT for his perfect guidance, patience, invaluable advices during this research, and for believing in me. I was pleasure to work under his guidance.

Special thanks to my family, for their kind help, patience and their spiritual support at every stage of this study.

My sincere appreciation also extends to my friends and to those who gave me the delight of smile.

Finally I would like to thank to those who took part in completion of this thesis.

TABLE OF CONTENTS

Page

LIST OF FIGURES

Page

LIST OF TABLES

Page

CHAPTER 1
INTRODUCTION

1.1 Background of Manna and Manna Bar

The history of manna goes back to three thousand years. Clearly, it has been mentioned in Holy Quran AL-Bakara (verse 57). In the earliest time, manna has been known in Asia Minor (Harrison, 1950). Manna is mainly obtained in Penjween-Sulaymaniyah in north of Iraq, where every year, it is collected with thousands of kilograms between June and July (Bodenheimer, 1947). Manna is a sugary compound which consists of white to brown small tears and soluble in water (Lanza, 2005). It chiefly appears on the leaves of gallnut and oak trees which mostly grown in the mountains naturally, such as crystalline covered with a white crust, that is an exudate of tree probably wounds tree by insect (Sabry et al., 1961; Erkan et al., 2014; Leibowitz, 1944). Collected materials from the trees called natural manna or manna. Special confectionary produced of manna sold in Baghdad under the name of "man es-simma" means the manna from heaven (Bodenheimer, 1947). Manna is also used for production of local sweets, delicious cakes mixed with nuts, bread and a medicine for treatment of minor disease since Noah flood in this region (Sabry et al., 1961; Erkan et al., 2014; Leibowitz, 1944).

Some grocers and producers of confectionary in Al-Sulaymaniyah city reported that it falls down from the sky and leaves, or produced by the insect. Erkan et al. (2014) reported that manna "gezo" is a traditional sweet, and generally consumed it which exists in South-East of Turkey. It is somehow considered as an unbelievable story as it is said that manna is collected through the rain in the region. The formation of manna is based on two bases according to the researchers. First, it is believed that manna is created as a result of wound the leaves and branches on the some trees (Caligiani et al., 2013). Second basis is that it is excretions of some insects (Baker, 2008). Some researchers reported that manna is produced of excretions of aphids which are also called honeydew (Lodos, 1986; Grami, 1998). As well as some researchers showed that honeydew is essentially a waste product of aphids (Maschwitz et al., 1986; Baker, 2008).

Manna bar is a typical Iraqi-Iranian confectionary that made of manna, glucose syrup, sugar, egg white, cardamom and nuts (pistachio, walnuts, and almond). Manna bar produced in Al-Sulaymaniyah, Iraq, is very famous and this city has lots of famous firms. In factory, manna bar production starts by dissolving of manna in water, and boiling it until becoming a sauce or molasses. Then it cooks with glucose syrup, after a certain time egg white is added during the mixing and then cardamom with or without pistachios/walnuts is added. After that, the mixture is put in a plate and left about 10 hours. Manna bar to be ready for cutting. Finally, the produced Manna bar is packaged and is ready to sell.

There are lots of product resemble manna bar, such as Italian torrone, French or Spanish nougat, and Spanish turron, which are generally manufactured during Christmas time. They are produced with honey, inverted sugar, sugar, egg albumin, and types of nuts as pistachios or hazelnut, sometimes chocolate. Torron is manufactured in some regions in Italy such as Lombardy, Abruzzo, Calabria, and Campania in a traditional way (Speziale et al., 2010). Nougat bars produced for a long time in Spain and its manufacturing goes back for over 500 years, especially in two beautiful Spanish cities, which are Jijona and Alicante (Abellán et al., 1995).

1.2 The aims of the study were to:

1. Determine the effects of temperature and time on the physical and chemical properties during processing of manna bar.

2. Determine the effects of the amount of egg white on the physical and chemical properties during processing of manna bar.

3. Determine the effects of the amount of pistachio on the physical and chemical properties during processing of manna bar.

4. Determine physical and chemical properties of some commercial manna bar.

CHAPTER 2
LITRETURE REVIEW

2.1 Manna

2.1.1 History

History of manna dates back to about three thousand years ago. In one of the holy verses of Quran it has been mentioned, AL-Bakara (verse 57). Knowing manna returns to a long time ago, more concisely, it is known in Asia Minor, where still is one of the ingredients of preparing of local sweetmeats which is highly placed. The other forms of it are used for different purposes such as medicinal, mainly laxative properties (Harrison, 1950). According to some sources, it has been known from the earliest times as Nishida stated that manna was known from the Biblical times. From an early age, it has been used for food as a sweet material (Nishida & Kuramato, 1963).

After the Exodus, on the 15th day of the second month, manna has been discovered from Egypt. It could be the middle or the end of Siwan in India, which can be thought as late May or the early days of June. Manna production is a defined the season will show agreement on this date. Reports of manna can be found in Exodus 16 and Number 11, in the desert. It was considered that this manna was used to feed lots of people and furnished in big enough quantities and was like bread. However, it is also considered as a natural phenomenon, which is closely related to the deserts of Israelites. By a still aphid, in North part of Iraq, manna is produced in the very large oak trees. On the oak leaves, plant louse is sucked and rightly excretes honeydew, which are parts of the leaves. In 1943, Bodenheimer travelled to North part of Iraq in July. He visited Penjween where forests of manna producing were nearby in Sulaymaniyah, Iraq which was a complete failure that year for the manna crop (Bodenheimer, 1947).

In Persia, the history of manna usage dates back to thousands years ago. The medicinal properties of it were reported by the Sassanid (Tabasi, 1983; Sina, 1949).

Taranjebin, Shir-Khesht, Bid-Khesht and Gaz-Alafi are the most remarkable Iranian manna from others. The most economical and important manna is Persian manna or Taranjebin in the Persian herbal markets. It is also referred to Alhagi manna, Hedysarum manna, Merniabin manna, and Caspian manna in English. Taranjebin appears on the branches and leaves of some camel's thorn shrubs, which is also a semi liquid resinous. Unexpectedly, Taranjebin is not produced by these species wherever they grow. It is considered as it is in connection with climate, soil conditions, temperature, and the existence of an insect that belongs to the genus Larinus live on shrubs (Yazdanparats et al., 2014). The therapeutic manner of this type of manna is attributed to sacchariferous compounds (Takavar & Mohamadi, 2008).

2.1.2 Harvesting

From the end of spring to autumn is considered as the season of harvesting, which climate plays an important role. Manna, which is collected in very early morning, during night it exudates. Pointing to the old Persian works and writings, by shaking dried cut-off bushes Taranjebin (Ta) was collected into a large cloth, which is followed by winnowing thorns, leaves, etc., from it. By putting manna to a tub, tin, or basket, nowadays manna is produced under the shrub by hitting the stems with a piece of wood. The process lets the hardened parts of the manna to fall into the receiver. After the impurities are removed, it is dried under the sun and purified more exposing the final product to air (Ramezany et al., 2013).

In the season of collecting manna, rainfall and storms will make the manna to be reduced. Desert rats, Porateranchus and Artidideh aphis insects will decrease the manner to be collected. In the morning manna was collected as Exodus 16:21 explained, and it "melted when the sun grew hot." The melting is regarded as mistaken and late interpolation. The manna is collected by the ants only in an environment which the temperature surpasses 21°C. At the time the Bodenheimer (1947) visited, in most of the wadis, the sun rays usually accomplishes about 8:30 a.m. in the evening, the activity of these ants will stop. The ants in the lowlands begin very earlier. All the manna, which is gained between late afternoons to early morning the drops stay until the start of the activity in the mornings. They are very quickly collected and carried away. In the Middle East, the most well-known manna is Iraqi (Kurdish) manna which every year nearly thousands of kilograms are collected in June and July (Bodenheimer, 1947).

The gathering of Gaz (Iranian manna) may start in the late of August and it continues till mid-October, the time is convenient in terms of location and weather. Gaz is a commodity which its consumption is increased, but the ways and the method it is created still have not changed and stopped in a primitive level (Grami, 1998).

2.1.3 Physicochemical Properties

Aeinechi et al. (1976) investigated the physical and chemical properties of Gaz of Khunsar (Table 1). It is free of nitrogen, alkaloids, tannin, sulfur, and halogens (Br, Cl, and I). Its 1% aqueous solution has a pH of 5.5 and rotates polarized light to the right. Gaz of Khunsar is originally white or cream-colored while it may appear greenish or brownish- yellow in bulk, depending on impurities. It is hydrophilic, very sticky, and soft under normal conditions, breakable when dry, and readily soluble in alcohol and water. The exudate is very sweet due to its high fructose content. Hashemieh-Anaraki (1976) also displayed that the non-carbohydrate compounds of gaz were free of sulfur and nitrogen. Nicknejad (1976) also analyzed that (gaz- alafi), which is a type of manna, gathered from desert trees, and reported about a 10% fructose and 40% sucrose content. Rafiee-Alavi (1976) discovered the non-saccharide organic compounds in gaz-alafi. Frederick (1819) described the rheological properties of gaz of Khunsar: However the gaz when freshly gathered from the bush, admits of being sifted, still in this original state it is adhesive and brittle at the same time, qualities for which it is so remarkable after its preparation such as a sweetmeat. In cool weather below 20°C, if pressed, it sticks to the finger, but on being smartly struck with a bit of wood separates easily into small grains such as lump sugar (Grami, 1998).

Table 2.1 Quantitative analysis of gaz exudate (Grami, 1998).

Composition	**Percent (%)**
Moisture	15.6
Reducing sugars (mainly fructose)	41.2
Sucrose	2.0
Polysaccharides (yielding glucose, xylose, and mannose, through acidic hydrolysis)	31.2
Total ash (1/4 of ash insoluble in acid)	2.3
Gums and mucilage	3.0

The color of the manna “Gaze Khonsar” (It is one of the Iranian manna types) in basic form is yellow and which includes residues of the plant issues. It is soft when it is at a room temperature, it would be delicate and easy to be broken when it is dry. It will absorb moisture and it is able to dissolve in ethanol and water. The taste is sweet and pleasant (Aynehchi & Samuelsson, 1978).

The word ‘manna’ sometimes in some instances is referred to as the all organism, such as fungi and edible linchens. In some other types, the term is applied to the substances, which the origin is from the animals, and they are produced form plants indirectly. It is more often would be confused with the exudations of the plants (Harrison, 1950).

2.1.4 The Use of Manna for Food Services

Manna is known for ages in history, especially in Asia Minor, still the use of manna is present for preparing the local sweetmeats that until now are highly respected (Harrison, 1950).

When form the bush the “gaz” collected freshly, it appears to be sifted, because it has real form so it still delicate and sticky at the same time. One of the qualities is that, it is very remarkable as a sweetmeat after its preparation (Grami, 1998).

When manna is seen as a food, it is a natural sweetener and a good substitute of sugar for dieters and diabetics. Manna is delicious even if it laxative properties are taken away, it is good for eating. With another food which is tasty like honey and carob, it seems crunchy but easily dissolves in mouth (Lanza, 2005).

2.1.5 The Use of Manna for Medical Reasons

Manna has been used as a medicine. In Greece and Rome, the doctors thought that the medical treatment can be enhanced by it. Additionally, in the fifteenth century, the physicians in Salernitan School, had dealt with its medical properties. The properties of manna are looked again in medicines because its properties are very controversial and it is studied again with new interests. Manna is safe for different ages and genders; it is safe for pregnant women, children, and elderly. Manna is also used in cosmetics to smooth skins (Lanza, 2005).

The term manna has been used differently, for saccharine exudations, it has been used from different plants, which they are from different families and origins (Harrison, 1950).

Manna is natural compounds which contains the benefits of medicine and nutrition. In Persian language the word “Angabin” is used for manna, and it is used in the markets for traditional medicines. In Iranian medicine, different kinds of manna have been used as expectorant, antipyretics, laxatives and to treat hyperbilirubinemia (Ghasemi et al., 2003; Azadbakht & Alinejad, 2005).

2.2 Materials Used During Confectionery Production

2.2.1 Manna

The common Arabic name is “Man” for plant lice, and “man es-simma” means the manna of heaven for honeydew. This confirms that manna comes from the sky, because a number of small insects (Homoptera of different families) are discovered in Sinai, Iran, and Southern Iraq, and are called “Man” locally. They produce a product in a small amount which looks like manna and which is used such as a delicacy and as an ingredient in a very popular way. Kurdish manna is produced in the Middle East and is one of the most famous foods, which is collected in a big amount yearly in June and July. It is used for manufacturing in special confections. Commonly, it is discover that manna production is a biological phenomenon of the dry steppes and deserts. The liquid honeydew excretion of a number of plant lice, cicadas, and scale insects speedily solidifies by rapid evaporation. It obtains a granular masses and which are sticky and gathered and called manna (Bodenheimer, 1947).

In Iran, it is popular to collect the substance of plant for making a sweetmeat. The exudate created on plant, the sweet after producing in the town area, it is called “gaz of Khunsar”, and after the confection is generally referred to as “gaz”, it means manna bar. In the center of Iran, it is produced in a traditional confection that is made of sugar, gaz of Khunsares, egg white, starch, and almonds or pistachios, is called “gaz of Isfahan” which is a historic city name. In the past, gaz was used to produce for top quality nougat, and lower prices, called “nim-a-nim”, which means half and half, containing same amounts of sugar and gaz. recently, for producing the most of nougat; a small amount of gaz is used. Instead, synthetic compounds are used as substitutes to provide a similar glutinous property to the nougat, though some of the consumers can feel the difference (Grami, 1998).

Sabry and Atallah (1961) reported manna is a crystalline, white crust, that it is exudated from trees probably by insect injuries, and which is mostly believed in North of Iraq. It is used to confection product such as sweet drinks, manna sweets, and as well as mixed with nuts and flour to produce delicious cakes.

2.2.2 Honey

People have used honey as sweet, neutral food and flavorful, which is considered such as one of the oldest foods. Aroma and taste are two characteristics of this food (Kaškonienė et al., 2008). It is one of the famous foods in the world, including in the Unites states. Honey cannot be produced everywhere, floral sources can be existed as the main factors. The origin and location of honey can be known by aroma-related volatile compounds which are useful to determine it. More than 300 kinds of Honey are produced in the United States. Summer is a good season to collect honey from different sources of flower. at high levels in different types of honey, some volatile compounds are found such as benzaldehyde and furfural in blueberry, clover, wild flower (Overton & Manura 1994), and thistle honeys (Bianchi et al., 2011).

Turkey has an outstanding role among the countries which produce honey, due to its suitability regarding flowers for apiculture. Turkey's production of honey is 80.000

tons each year (Anonymous, 1997). Apiculture in Turkey has been produced increasingly with 4.1% per a year (Anonymous, 1995). The most important part of Turkey for producing honey is the west and middle of Turkey (Anonymous, 1994) Currently in Kahramanmaraş, possessing to the west of Mediterranean place, the production of honey has raised incredibly, but many different parameters about the quality of honey have not been researched so far.

Honey is classified according to its floral source. The physical properties of honey is changed depending on the floral source, water content, the proportion of the specific sugars, amino acids, organic acid, proteins, vitamins, enzymes, and phytochemicals it contains (White, 1975; Ball, 2007). Honey is produced from honey bees that harvest honey, sweet secretions from manna or other plants sucking suction suckers, instead of harvesting nectar (Leroy et al., 2011). Environmental factors may affect and change the water content of honey, such as humidity and inside the hives and weather (Olaitan et al. 2007). Temperature and storage conditions may change composition of honey (Stephens et al., 2015).

Honey is a very variable natural product, especially color and odor in the sensory properties, also sugar composition, water content, pH value, and ash content. These characteristics depend on the climate, floral type, and the practices of keeping individual bees (Golob & Plestenjak, 1999). Honey is identified as more than 150 different compounds in the volatile flavor fraction, but most of the compounds in the low mg/kg range have not yet been quantified or identified (Serra & Ventura, 2003).

There is confectionary product which contains of honey such as Jijona turr´on and Alicante. They are typical Spanish confectioneries (Vázquez et al., 2006). Torrone is a typical Italian confectionery product (Speziale et al. 2010). In addition, Spanish Turrón, Italian Torrone and French Nougat are produced from honey (Hojjati et al., 2015).

2.2.3 Sugar and Glucose Syrup

Actually, the phase sweetener is the combination of various sugars in most confections, and each type of sugar affects the others, particularly in the solubility concentration of solution. For example, the presence of corn syrup and/or invert sugar is the reason to a substantial reduction in sucrose solubility (Pancoast and Junk

1980; Mageean et al., 1991) due to the competition among the molecules of sugar for water. Hence, the addition of invert sugar or corn syrup to a sucrose solution results in solubility of sucrose which is decreased (Hartel et al., 2011).

Glucose syrups are known as cone syrup in North of America. It is produced from starch sources as wheat, potatoes, and maize. Offering different functional properties to sugar, glucose syrups are generally used in manufacturing of food and other industries, because that is extremely accomplished sweeteners. Also, that is a key ingredient in confectionery products, sports, drinks, soft drinks, beer, sauces, and ice creams. Furthermore, it is essential in industrial fermentations and pharmaceuticals. (https://www.bookdepository.com/Glucose-Syrups-Peter-Hull/9781405175562)

High-fructose syrup (HFS) is used in many food production, because it has high sweetening power and contain around 53-54% glucose and 42% fructose. High-fructose syrup can be replaced into invert syrup and liquid sucrose in beverage products and many foods such as backed goods, confectionary jam, jellies, ice cream, canned fruit, and soft drinks (Ashby, et al., 1987).

In industry, fermentation can be used as glucose syrup which contains more than 90% (Dziedzic & Kearsley, 1995). In confectionary industry, syrup is used which contains different amounts of maltose, glucose, and higher oligosaccharides, generally contain 10% to 43% glucose, depends on the grad (Jackson, 1995). Enzymatic process used for changing some of glucose to fructose, also sweetest product can produce with high fructose corn syrup (Knehr, 2008).

2.2.4 Flour

Wheat flour is one of the most important staple food sources in the world. Heat-treated flours (HTFs) is produced by applying dry heat to base flours under different temperatures and for times they have gained popularity in food production, including coatings, binders, baked foods, and thickeners (Neill et al., 2012; Shi, 2009). Volatile compounds in foods create odors/aromas, and their types and concentrations dictate olfactory and taste perception (Zhou et al., 1999).

Wheat flour is the source of some products such as bread and pasta, generally are consumed in well-developed countries (Rebello et al., 2014). These products have great national values and contain (10–15%) of proteins, (60–75%) of starch (Troccoli et al., 2000). Also it has some pro-health components such as dietary fiber, phytic acid, and phenolics. However, their contents are low compared to vegetables, nuts, and fruits (Yu et al., 2002). By genetic factors, variety can be determined to find the quality of wheat flour, and also breeding conditions (fertilization and weather conditions) (Troccoli et al., 2000). Some researches indicate that quality of wheat flour can be improved by sprouting (Žilic et al., 2014). When the quality of the wheat grains is low, it would be very important, and for milling cannot be used (Dziki et al., 2015).

2.2.5 Egg White (Egg Albumin)

Egg white is used in many food products as a key ingredient in food industries and it combines high nutritional quality (Seuss-Baum et al., 2011) with excellent functional properties (Lechevalier et al., 2011). However, egg white is one of the leading reasons of food allergy in childhood (Moneret-Vautrin, 2008). Egg white has a great benefit to human nutrition because egg white protein contains high content of essential amino acids, and high bioavailability. However, dry heating effects on the nutritional quality of egg white proteins which are poorly documented by industrial processing. Some studies have considered the influence of dry heating on laboratory digestion of proteins as a prerequisite for the quality of nutrition (Schmidt et al., 2007).

In general, egg white foam is produced by whipping, and it consists intermittent air phase that is dispersed within a continuum of liquid (Pernell et al., 2002). Various mechanisms are involved in the formation of the foam, such as the transfer of individual proteins to the air/water interface and the formation of an interstellar film that stabilizes the foam due to denaturation of protein (Wilde & Clark, 1996). The egg white foams are typically stabilized and sweetened by using different kinds and quantities of hydrocolloids and sugars to obtain confectionary products that show sweetness intensity and different textures. For example, in manufacturing, marshmallows are produced with gelatin and a cooling process at surrounds temperature for several hours in order to produce the juicy, soft and elastic product while the meringues show rather crispy texture and brittle due to drying step at 100°C. The mechanisms of air retention has been studied in a series of liquid and physical properties of foams which produced on a large scale in terms of surface tension of protein solutions, yield stress, aerobic phase of foams, average intercept length, fracture fraction, air bubbles (Davis et al., 2004; Luck et al., 2002; Pernell et al., 2002; Sun et al., 2008).

A variety of flavors, colors and textures is come in processed foods intend to delight consumers. The unique textures can be supported by the formation of foam and this relates to much food such as cake bread, ice cream, and confectionery products (Campbell & Mougeot, 1999). The chemical and physical mechanisms are responsible for the foam properties of these systems, which are of importance for several reasons. The processors want flexibility in the selection of the ingredients so that the substitution of milk, soy or other protein is of interest to protein. The latter goal led to early studies on the foam and interfacial properties of proteins (Peter & Bell, 1930).

2.2.6 Spice

Spices, as a food additive, are used to provide aroma, color, flavor, and food preservative capabilities (Santiago-Adame et al., 2015). Flavor affects food consumption and important characters in consumer satisfaction (Madene et al., 2006). However, the main factors limiting the development of the flavor industry are the long residual acts and thermal stability of fragrance and flavor (Xiao et al., 2011).

2.2.6.1 Cardamom

Cardamom seeds have a warm, aromatic and slightly pungent. Hence it is used as a flavoring agent in perfumery, food preparations, tea, beverages and medicines (Chempakam & Sindhu, 2008). Manna is flavored with cardamom in Iraq (Lanza, 2005).

Cardamom is commonly known as the queen of spices, and that it belongs to the family Zingiberaceae and genus Elettaria. After saffron and vanilla, cardamom is the third most expensive spice. Cardamom is monopolized by India, and cultivation is confined to three states, they are Tamil Nadu, Karnataka and Kerala (Korikanthimath et al., 2002). Cultivation of cardamom started in Sri Lanka, Guatemala, Laos, Thailand, Vietnam, Nepal, Costa Rica, El Salvador, Tanzania and Mexico (Mehra, 2001).

In cardamom oil, several flavours compounds are identified such as α-phellandrene (0.2%), α-pinene (1.5%), β-pinene (0.2%), myrcene (1.6%), sabinene (2.8%), limonene (11.6%), 1,8 cineole (36.3%), terpinolene (0.5%), γ-terpinene (0.7%), linalyl acetate(2.5%), linalool (3%), terpinen 4-ol (0.9%), α-terpinyl acetate (31.3%), α-terpineol (2.6%), geraniol (0.5%), methyl eugenol (0.2%) citronellol (0.3%) and trans-nerolidol 2.7 (baby, 2016).

2.2.6.2 Vanilla

Vanilla is defined as a flavor queen. It is one of the valuable natural plants, which is mostly used in cigarettes, food, pharmaceutical products, high-grade cosmetic, etc. (Brunschwig et al., 2012; Helena et al., 2013). In food manufacturing, vanilla is used such as flavor enhancer for tea, wine, candy, chocolate, dairy product, pastry and others foods in order to rich them with sweet scent and cream. Green vanilla beans are flavorless and odorless. The characteristic flavor of vanilla beans is only formed during curing process, which results in 2% of vanilla beans and more than 170 other compounds with delicate sweet fragrance (Mark & Rob, 2002).

The main constituent of vanilla extract is (4-hydroxy-3-methoxybenzaldehyde), which is a flavoring ingredient used in beverages and food. Natural vanilla is produced from the beans of the Vanilla planifolia and tropical orchid, and it is expensive because limited supply of the vanilla bean (Lavine et al., 2012).

2.2.6.3 Cinnamon

Cinnamon in Europe and USA is the second important spice and it comes after black pepper (Jayaprakasha et al., 2007). Its consumption is related to healthy benefits, such as inhibition of cancer cells proliferation, antimicrobial activity, glucose control in diabetes and protection against common flu (Anderson et al., 2004).

Chinese from the past times and Egyptians used cinnamon for preparing food and traditional medicine (Elshafie et al., 2012).

Cinnamon is a plant with many uses as an herbal medicine and it contains tannin, mucilage, resin, and essential oil, among which essential oil is the most important constituent. cinnamic aldehyde or cinnamaldehyde is made the major protein of the essential oil (Molania et al., 2012). Aroma and flavor are responsible by the Cinnamaldehyde of cinnamon (Peterson et al., 2009).

Herbs and spices are not used only to flavor purpose but also used in the human diet in a source of health-positive bioactive compounds (Przygodzka et al., 2014; Valverdú-Queralt et al., 2014). Cinnamon is a unique materials and suitable for different industrial applications and pharmacological (Lvet al., 2012; Viteri Jumbo et al., 2014).

2.2.7 Nuts

2.2.7.1 Pistachio

Pistachio kernel is a good of fat (50–60%) also it contains acids (linoleic, linoleic and oleic acids) which is unsaturated fatty acids, it is very crucial for human diet (Shokraii, 1977; Maskan & Karatas, 1998;). In the food industries of confectionary, as a snack pistachios are used. There is a challenge for many useful ingredients and vitamins in the dried pistachios. This leads to lose many nutrition and the vitamins are like vitamin A and C, and protein during dehydration. The quality of dried pistachio changes differently according to the ways the pistachio harvested, it is affected by the fast and quality of harvesting handlings with hulling, drying and post drying storage. Different reactions can occur during the process, for example during the drying process it might be affected by reactions negatively that causes different results like degradation in quality. In dried foods, one of the effective deteriorative reactions is the oxidation of lipids (Tavakolipour, 2011). In Pistachio kernels, there is a high rate of lipid and the unsaturated fatty acid content, it has been easily affected from oxidation and makes it very sensitive to rancidity. Rancidity affects pistachio and nearly 3% of pistachio production can be lost. Also fungal growth can be affect because of different weather conditions which is followed by inappropriate drying practices (Venkitasamy et al., 2017). Wild pistachio kernels have a very deep green color. It gives different qualities to pistachio as it is used in ice-cream and pastry industries. (Woodroof, 1979).

2.2.7.2 Walnut

Walnuts are considered as of the ancient plant nuts which has been cultivated. Walnuts are closely originated in northern America, eastern Asia, and southeastern Europe. It has different purposes as many other plants have. One of the purposes is to use it for medical purposes in China and Europe. It has been used for healing head wounds in the 16th century. Because of having the shape of walnuts as the human brain, Greeks believed that it had been useful for the injuries of head (Rosengarten, 2004).

Walnut seeds can be considered as a good source of nutrients, especially unsaturated fatty acids and proteins. There is a big amount of oil relatively about (52-70 %) with precious nutritional properties because of the composition of fatty acid which is characterized by the existence of monounsaturated (such as oleic acid) poly unsaturated fatty acids (PUFA) (Crews et al., 2005).

A valuable crop or important crop is seen as a cultivated walnut both for trade or local consumption. Walnut is a kind of food which is nutrient-dense and mainly related to protein profile and its lipid. The process of extracting walnut oil is taken place by using hydraulic or screw press , also there is another kind of extraction which is by solvent and CO2 supercritical. (Martínez et al., 2008 & Martínez et al., 2010).

Walnuts provide different quantities of various substances, for example, it has lipids (up to 70%), Proteins (up to 24%), and 630kcal for each 100g walnut, which these elements are for over than 84% of the walnut kernel weight (Ravai, 1992). There is a rate of 16.66% protein and 66.90% lipids in walnut when it is in the form of a dry weight basis (Sze-Tao, 2000).

2.2.7.3 Almond

Almond has a very high energy (approximately 600 kcal/ 100 g), with the high content of protein (over 25%) and lipid (about 50%). Almond is used in condiments, cakes, tamale-like cakes as an ingredient as a roasted form for production of handmade oil (HPAO), or fresh consumption, which is recently on a small scale it is done with a rustic technique using a water at high temperature (Aquino et al., 2009; Sousa et al., 2011; Torres et al., 2016).

Nutritional ingredients and numerous bioactive compounds are present in Almonds (Prunes dulcis). It has different species as it is divided into two kinds, sweet and bitter almonds when it is based on its taste. Almonds (Borr as et al., 2014), without paying attention to any pre-processes, are used for different foods in industries, especially sweet almonds for direct consumption (Loghavi, Souri, &Khorsandi, 2011).

Almonds (Prunusdulcis (Mill.) D.A. Webb) are eaten in different ways, such as when it is fried, roasted, or raw. Almonds are also used in different ingredients of products as marzipan and ‘‘turron”. For example it is used in the traditional Spanish products, snacks, and sauces. It is used to make substitutes for different foods as it is processed to produce almond milk, which is consumed instead of cow’s milk (Aranceta, 2006).

2.3 Manna Bar

There is no any scientific information about production of manna bar in Iraq. Therefore, information about its production is taken from visiting of some factories and grocers in Al-Sulaymaniyah, Iraq. One of them is Tofiq Halwachy factory, it is the first and the most famous factory in Iraq. Manna bar is produced in two steps, first, sauce or manna’s molasses of manna is collected and second producing manna bar (confection product).

2.3.1 Purification of Manna

Manna can mix with dust and leaves after collecting from the mountains, after transferring to the factory; it soaks in water with shaking until dissolving. It is better to dissolve in hot water or boil it up to 70 ºC, then leave it for (1-2) days without shaking in order to separate leaves and mud. The mud (precipitate at the bottom) and leaves (at the top) are removed by filtration and clear syrup obtain. Then it boils till becomes a sauce or molasses. When the manna is collected, does not use and set in storage, generally it becomes so rigid as stone especially in moist places, in this case, it needs crushing and grind around (1-2 cm) by hammer.

2.3.2 Production of Manna Bar

For producing manna bar, first the glucose syrup is cooked by shaking till thaw, then the sauce is added which is prepared at the previous step, and complete the process of cooking time. To know the cooking time, there are some ways to indicate it. One of them takes a bit of mixture by falling it into the cool water. If it forms a ball shape, it means the cooking time has finished. The time is changeable according to the amount of the mixture to let it cool down. In another side, foam is prepared of egg white and some factories add "aspon" which is (wood and boil with water), then the water is used with egg white for preparing foam by a mixer or machine shaker. After that, the foam is added to the mixture and mixing it until it will turn to manna bar. Sometimes the mixture is exposed to a low heat, especially when it contains much foam, the mixture will be soft when there is a lot of foam, therefore moisture is evaporated by the heat. There are some ways to indicate the mixing time. One of them is famous in using in the factories to indicate the different stages of time. And then take a bit of mixture by knife and put it into cool water for a few seconds and take it out, then test it by hitting with fingers. If it is broken, it means the mixing time has finished. The following step is adding cardamom and pistachio or walnuts with mixing. And then the mixture is transferred to tray and it is covered by a layer of flour to prevent sticking. At the end, cut and put it into a wood box with flour or packaging it by nylon.

2.4 Iranian Gaz Production (Manna Bar) and Texture Profile Analysis

Hojjati et al. (2015) state that traditionally Gaz is produced from gaz-angebin, glucose syrup, sugar, rosewater, egg white, and almond and pistachio. For producing a good quality, no need to add oil, flour, starch or synthetic preservatives in its formulation. For manufacturing of gaz, gazangebin is dissolved in hot water (below boiling point) and filtered out. After that, it is put in a copper container with glucose syrup, sugar and rosewater and cooked at medium temperature for 3 hours with mixing. Then egg whites are added and beaten for 2 hours in order to reach desired consistency. After that pistachios and almond are added for 5 minutes in order to let all ingredients to be well mixed, after that, the mass is transferred to mold and using rolling pin to confer the desired shape. To obtain final product, it is cut and put in wooden boxes, although nowadays in some shops they use cardboard, plastic boxes and metal. Iranian gaz is appeared such as French nougat, Italian torrone, and Spanish turrón, but different from materials, manufacture process and especially texture features. The same formula is used for preparing 7 samples but only different percentage of pistachio and almond. Table 2.2 shows the texture profile analysis parameters (Hojjati et al., 2015).

2.5 Confectionery Production Resemble Manna Bar and Properties

2.5.1 Producing Spanish Turrón, Italian Torrone and French Nougat

Turrón, torrone and nougat are typical Spanish, Italian and French confectionery products which are produced from almonds, sugars and honey by traditional ways. Local raw materials are used in manufacturing of these products. Almond and honey are the key ingredients. Of their products Vazquez et al., (2006) concluded that the most important quality parameter in commercial transactions of this type of confections is the almond percentage. For example in Spain, turrón is commercially classified according to its almond content, which is legislated by the Technical-Sanitary Regulation (R.T.S., 1982). The prices of almonds are quite different and mainly depend on their sensory quality and production where being located within the protected geographical regions (Verdu et al., 2007).

Also confectionary in Taurianova (Reggio Calabria, Southern Italy) the quality of final products depends mainly on both the quantity and quality of almonds and honey. In general, orange, honey and almonds of Sicilia or Puglia (cultivar Pizzuta d'Avola) are used in manufacturing of torrone. Finally, in France mainly lavender honey from the Provence region is used for preparing nougat (Taverna, 2009).

2.5.1.1 Producing Spanish Turrón

For production of turrón, honey, glucose, sucrose, dextrose and water are placed in a pot of boiler and homogenized with an impeller anchor. The syrup concentrates up to 80 ° Brix. At this point, egg albumin and toasted almonds are added and the entire mass is homogenized manually. In this stage, obtaining a product is called Alicante *turrón*. When it is cold, it is crushed by a stone miller and the solid mass. In the remaining time, the solid particles are suspended in continuous fat phase and almond is released. The suspension is heated at 50-60 ºC to 1 hr. After that, it is heated further for 1 hr more at 70-80 ºC. Then semi-solid soft mass is obtained, which is called Jijona turrón. The product is harder at room temperature (Vazquez et al., 2007; Chiralt Boix et al., 1999; Lluch et al., 1992; Chiralt et al., 1991).

2.5.1.2 Producing Italian Torrone

For producing Italian torrone, glucose, sucrose of sugar and honey, are mixed in a copper container at uniform speed with heating at low temperature for 2 hours in the "torroniera", where fresh egg-whites are added. After that, the caramel (previously prepared in another copper container), natural vanilla extract, pistachios and roasted almonds are added. All ingredients are mixed properly, then transferred to a marble table and mixed to give the desired shape with wooden frames or suitable shapes. After that both surfaces covered with wafer, cut and packed, this product is called torrone vaniglia (vanilla torrone). On the other hand, it could be used in chocolate for covering the mixture and the product is called torrone gianduja (chocolate torrone). In general, two types of torrone have difference composition and process, torrone gianduja (chocolate torrone) has harder texture because of more heating and amount of almond higher than torrone vaniglia (vanilla torrone).

2.5.1.3 Producing French Nougat

To be qualified as Montelimar nougat, confections should have 16 % Provence lavender honey and at least 30% of peeled almonds or 28 % almonds and 2 % pistachio nuts. The traditional nougat recipe consists of honey, sugar and water produced by heating with mixing, after obtaining syrup egg white (foam) is added and mixed. Almond, crushed pistachios, and touch vanilla are added. Then the product is moulded, and heated with low temperature (35ºC) for 12 hours after cutting and packing. The main difference between the two types of nougats (dur and tendre nougats) is the heating temperature, high temperature leads to hard texture.

The textural properties of the commercial turrón, torrone and nougat are quite heterogeneous (Lazpita et al., 1991) due to several causes:

1. The fact that during production, each company uses various temperature and holding time during the heating steps, heating and time have influences on the final product.
2. Industrial equipment has influence on the final product (highly viscous mass), because the homogenization level change the texture of product.
3. Also, composition is affected from oversaturation of syrups, small amount in moisture content and sugar composition.

Table 2.2 Texture profile analysis parameters of gaz samples (Hojjati et al., 2015).

sample	Hardness (N)	Adhesiveness (N.s)	Cohesiveness (%)	Sprimginess (%)	Chewiness (N)
AL %28	122 ± 2[b]	-1.9 ± 0.2[a]	69.7 ± 2.1[a]	83.3 ± 2.0[ab]	73.4 ± 1.2[b]
AL %40	257 ±1.7[a]	-3.5 ± 0.4[a]	70.7 ± 1.5[a]	78.8 ± 0.2[b]	146 ± 8[a]
MIX %18	56.9 ± 1.7[cd]	-5.0 ± 0.4[ab]	76.7 ± 1.2[a]	86.2 ± 0.4[ab]	37.4 ± 0.4[bc]
MIX %28	70.3 ± 5.5[cd]	-8.5 ± 0.8[abc]	70.7 ± 1.0[a]	86.3 ± 0.5[ab]	42.1 ± 3.3[bc]
PST %18	31.6 ±0.9[d]	-9.9 ± 1.5[abc]	88.2 ± 0.4[a]	92.3 ± 0.3[a]	28.3 ± 0.2[c]
PST %28	54.8 ± 3.2[cd]	-20.4 ± 1.8[bc]	83.5 ± 1.9[a]	86 ± 0.8[ab]	33.5 ± 0.7[bc]
PST %40	86.8 ±5.4[bc]	-21 ± 3.0[c]	79.3 ± 2.5[a]	85 ± 0.7[ab]	58 ± 2.4[bc]

The ± values indicate standard error. Values followed by the same letter (superscript), within the same column, were not significantly different ($P < 0.05$), Tukey's least significant difference test.

AL is (almond), MIX is (pistachio and almond), PST is (pistachio).

Table 2.3 Main composition (%) variable of Spanish turrón, French nougat and Italian torrone as affected by producing company (Hojjati et al., 2015).

Product	Moisture	Protein	Oil	Sugar	Almond
“1880”	5.02 ± 0.11	15.96 ± 0.39	43.42 ± 0.38	33.23 ± 0.37	69.1 ± 0.4
“El Lobo”	4.28 ± 0.20	14.45 ± 0.23	39.78 ± 0.42	38.25 ± 0.27	64.6 ± 0.3
“Du Roy René”	4.83 ± 0.21	7.35 ± 0.21	21.05 ± 0.30	70.02 ± 5.08	33.2 ± 6.1
“Reflets de France”	5.90 ± 0.23	7.60 ± 0.19	16.88 ± 0.45	65.16 ± 4.64	34.4 ± 1.5
“Bar D’Agostino”	3.69 ± 0.07	9.26 ± 0.10	29.17 ± 1.90	59.11 ± 0.98	40.8 ± 3.1
“Bar Golden”	2.84 ± 0.13	6.94 ± 0.13	29.60 ± 2.13	57.60 ± 1.42	34.5 ± 4.0

Spain (“El Lobo” and “1880”), France (“Du Roy René” and “Reflets de France”) and Italian (“Bar D’Agostino” and “Bar Golden”)

Table 2.4 Parameters of the texture profile analysis of Spanish turrón, French nougat and Italian torrone as affected by producing company (Hojjati et al., 2015).

Product	Hardness (N)	Adhesiveness (N.s)	Cohesiveness (%)	Sprimginess (%)	Chewiness (N)
“1880”	55.3 ± 3.6	3.39 ± 0.31	16.4 ± 0.7	50.3 ± 3.3	4.42 ± 0.36
“El Lobo”	36.9 ± 2.4	0.68 ± 0.06	24.6 ± 1.1	55.3 ± 3.7	4.86 ± 0.40
“Du Roy René”	20.3 ± 1.9	7.72 ± 0.75	50.5 ± 4.3	84.4 ± 0.6	7.85 ± 0.49
“Reflets de France”	104 ± 8	8.75 ± 0.83	51.3 ± 2.9	82.7 ± 7.2	43.8 ± 5.2
“Bar D’Agostino”	43.7 ± 6.5	1.24 ± 0.17	24.2 ± 2.3	34.6 ± 3.6	3.73 ± 0.73
“Bar Golden”	127 ± 27	3.49 ± 0.57	12.6 ± 1.5	88 ± 28.7	11.1± 2.8

Spain (“El Lobo” and “1880”), France (“Du Roy René” and “Reflets de France”) and Italian (“Bar D’Agostino” and “Bar Golden”)

CHAPTER 3
MATERIALS AND METHODOLOGY

3.1 Materials

Glucose syrup, egg white, pistachio, and cardamom were obtained from local market in Gaziantep, Turkey. Manna was obtained from a grocery in Al-Sulaymaniyah, Iraq. Hand mixer (King, Model Deluxe Turkey) was used to prepare foam from egg white.

3.2 Experimental Design

Three kinds of Manna bar were produced at different processes and recipes. All information are given in Tables 3.1, 3.2, and 3.3.

For each sample, moisture content, pH value, color, and texture analysis were determined and for some samples determined protein content, fat content, total sugar, ash content and sensory analysis.

3.3 Preparation Molasses or Sauce of Manna (Purification Manna)

Manna was taken from a grocery, which could have leaves and dust. For that reason, manna was soaked in hot water and stirred until completely dissolved. Then it was held for 36 hours without shaking in order to separate leaves and mud. The mud (precipitated at the bottom), and leaves (at the top) were removed by filtration and clear syrup was obtained. Then it was boiled till becomes a sauce or molasses (Figure 3.1).

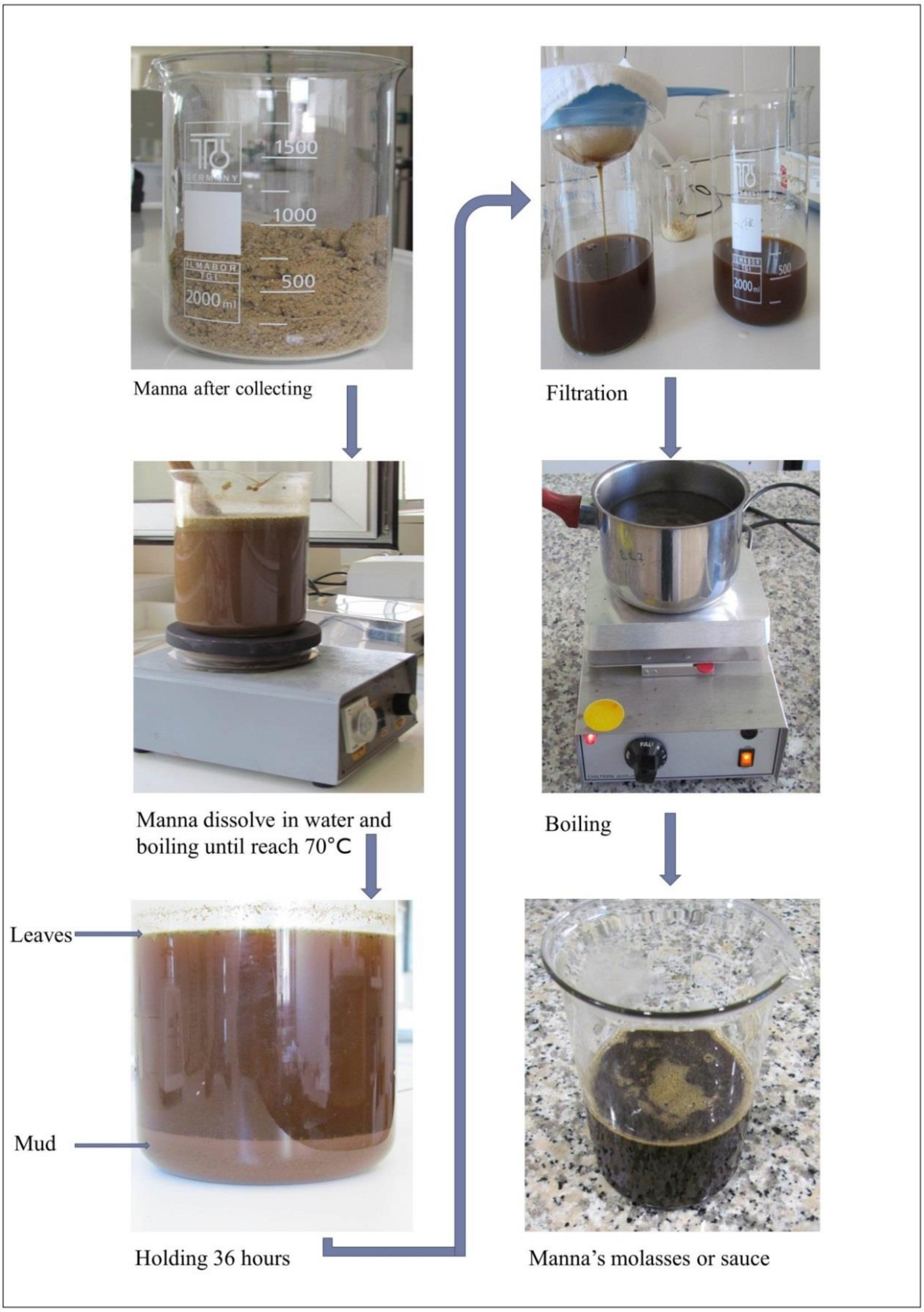

Figure 3.1 Purification of manna and preparation molasses of manna

3.4 Manna Bar Production

Glucose syrup was put into container and start for cooking after that the molasses was added (Figure 3.2). This mixture was cooked according to expermintal design values. Moreover, it was cooled down for 5 minutes, and then foam was added into the mixture, which was prepared from egg white by shaking. Then cardamom and pistachios were added to the mixture with mixing until obtaining homogenous mixture. At the end, it was transferred to a mold and covered by flour. The manna bars containing different amount of pistachio or egg white used this study were prespared according to Tables 3.1-3.3.

3.4.1 Production of Manna Bar at Different Processes

27 samples of manna bar were produced at different cooking temperature, cooking time, and mixing time, but at constant recipe. The processes and the recipe are given in Table 3.1.

Table 3.1 Process parameters used in manna bar production

Cooking temperature	Cooking time (min)	Mixing time (min)	Recipe for each sample it was consisted (%)
100°C	5	10, 20, and 30	Manna 26.0 Glucose syrup 65.0 Egg white 8.0 Cardamom 1.0
	10	10, 20, and 30	
	15	10, 20, and 30	
110°C	5	10, 20, and 30	
	10	10, 20, and 30	
	15	10, 20, and 30	
120°C	5	10, 20, and 30	
	10	10, 20, and 30	
	15	10, 20, and 30	

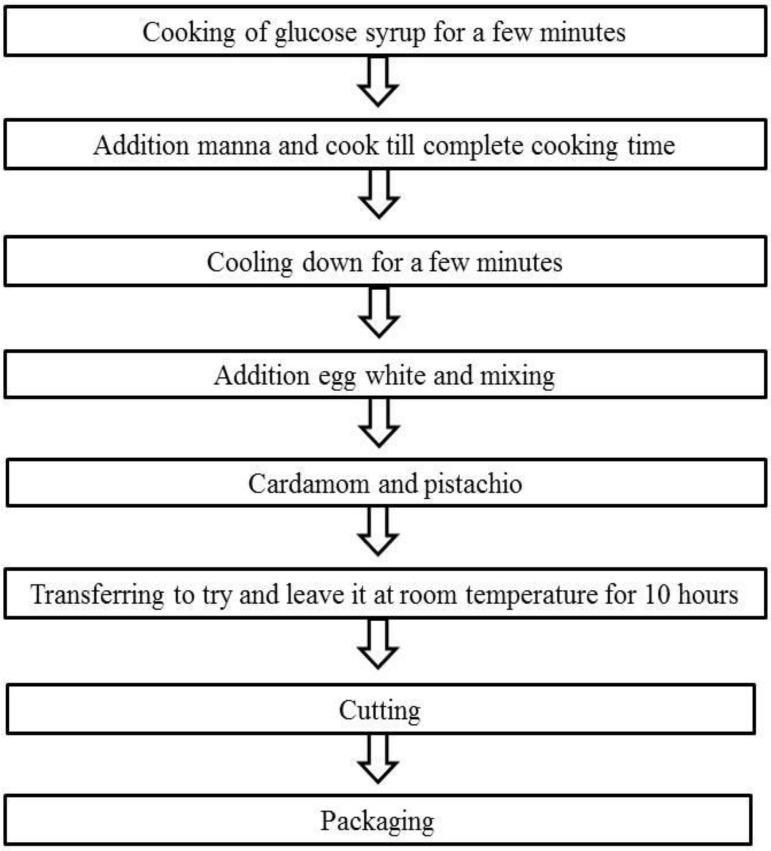

Figure 3.2 Flow diagram of the manna bar manufacturing process

3.4.2 Production of Manna Bar With Different Percentages of Egg White

The egg white affects the final product quality of manna bar, especially on the texture. Therefore, the egg white was used in different amount to find the difference between them. The mixture of manna bar mixture consisted of 28.3% manna, 70.7% glucose syrup and 1.0% cardamom were prepared. After that, it was divided into 12 parts. Samples of manna bar containing egg white were produced at constant cooking temperature, cooking time, but at different mixing time (5, 10, and 15 min) according to the recipe given in Table 3.2.

Table 3.2 Production manna bar at different percentage of egg white

Cooking temperature	Cooking time (min)	Egg white (%)	Mixing time (min)
120°C	15	2.5	5, 10, and 20
		4.0	5, 10, and 20
		5.5	5, 10, and 20
		7.0	5, 10, and 20

3.4.3 Production of Manna Bar Using Different Percentage of Pistachios

Four samples of manna bar were produced at constant processes and material, but with different percentages of pistachio. The mixture of manna bar consisted of 26% manna, 64.5% glucose syrup, 8.0% egg white and 1.5% cardamom. After completing the cooking and mixing time, the mixture was divided into four parts; different percentages of pistachios were added into each of them according to the recipe given in Table 3.3. Then the mixture was transferred to the tray.

Table 3.3 Production manna bar using different percentage of pistachios

Cooking temperature	Cooking time (min)	Mixing time (min)	Sample	Pistachio (%)
120°C	15	30	P1	15.0
			P2	25.0
			P3	35.0
			P4	45.0

3.5 Sample Preparation and Analysis

For all analysis, duplicate samples were taken after producing manna bars. Molds were used for TPA analysis. The mixture was put into molds after the mixing time, the dimensions of molds were 4×3×2 cm^3. However mold was not used for which samples were produced with pistachios. After completing the transferring to a tray, and it was cut about 3×2.5×1.5cm after 10 hours.

3.5.1 Determination of Moisture Content of Manna Bar

About 2g of the sample was taken for moisture content analysis. Moisture content was determined by the use of oven method at 105°C until constant weight reached (AOAC, 1990). Then it was weighed after cooling it at a room temperature in a desiccator.

3.5.2 Determination of pH Values of Manna Bar

The measurement of pH value was carried out on a 10g of sample dissolved in 90 mL of distilled water. The pH value of the sample was determined by using a HANNA Instruments Model 211 pH meter (Portugal).

3.5.3 Determination of Color

The samples were milled and mixed, then color measurements (L*, a*, b*, and YI values) were made by using a Hunter Lab Color Flex (A60-1010-615 Model Colorimeter, Hunter Lab, Reston, VA). L* the lightness coordinate, a* the red/green coordinate, with +a* indicating red, and -a* indicating green, b* the yellow/blue coordinate, with +b* indicating yellow, and -b* indicating blue. Browning Index [BI] was calculated using Hunter L*, a*, and b* values (Bozkurt and Bayram, 2006) as follows:

$$BI = \frac{100(x-0.31)}{0.17} \qquad (3.1)$$

Where

$$X = \frac{a^{*} + 1.75L^{*}}{5.645L^{*} + a^{*} - 3.012b^{*}} \qquad (3.2)$$

3.5.4 Determination of Texture Attributes of Manna Bar

In this test, two compressions were made to find an instrumental texture profile analysis (TPA) as described by Bourne et al. (1978). All instrumental texture analyses were conducted at room temperature 24 ± 2ºC equipped. Test conditions were: (36mm) diameter aluminum cylindrical probe and stainless spherical probe, test speed 2 mm/s; pre-test speed 2 mm/s, post-test speed 5 mm/s; compression (strain) 50 %; and 50 kg load cell. Hardness (g), adhesiveness (g.s), springiness (%), cohesiveness (%), and chewiness (g) values were obtained from Texture Expert Exceed Version 2V3 (Stable Micro Systems, 1998).

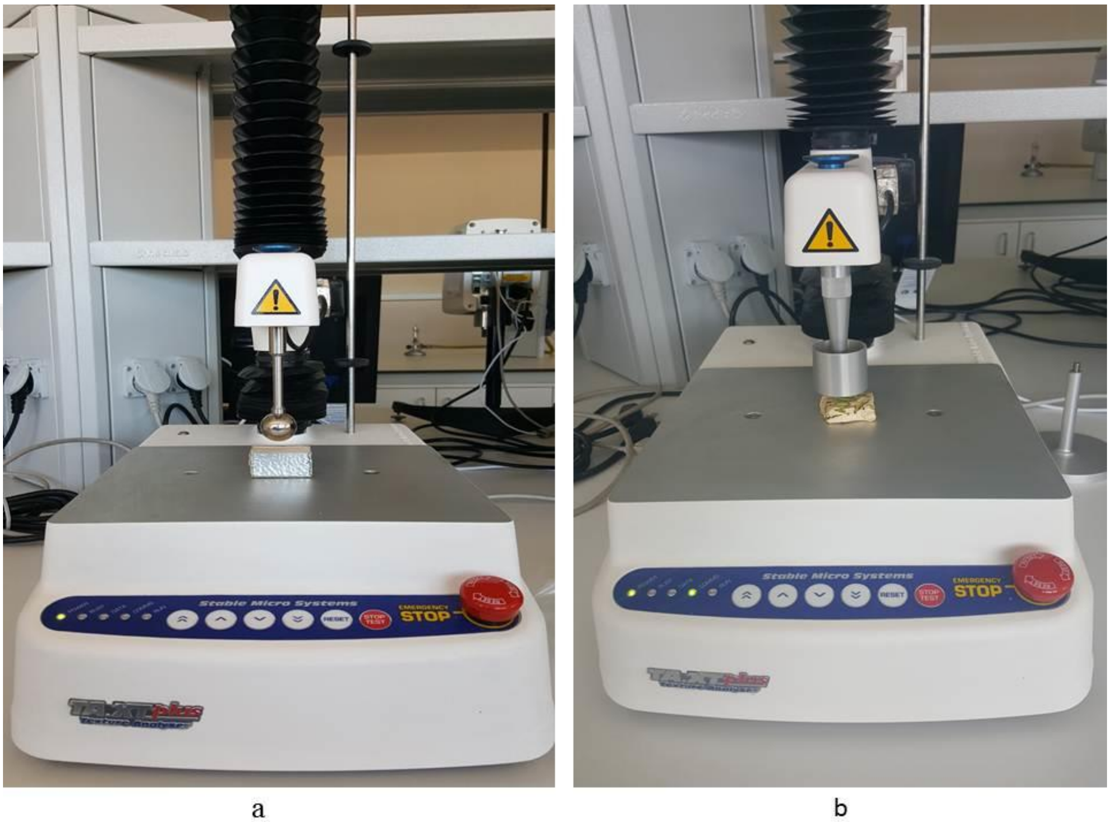

Figure 3.3 Photographs of Texture Analyzer, sample analysis in the mold by the spherical probe (a), sample analysis by the cylindrical probe (b)

3.5.5 Determination of Protein Content

For determining the protein content of manna bar, Kjeldahl method was used (AOAC, 1990). Approximately 1 g of the samples was weighted and put in Kjeldahl tube. 7 g potassium sulfate, a bit of copper sulfate and 12 mL (95%) sulfuric acid was added into the tube. A pre-burning operation was conducted in fume hood at 400°C for 40 min. Then the liquid in tube turned green, distillation was made with Kjeldahl protein device (FOSS, Kjeltec TM 2200 mode, Sweden). In the last step, the titration of the sample was conducted using 0.1N of HCl.

3.5.6 Determination of Total Sugar

Determination of sugars (total sugar) was carried out through Lane and Eynon method. For preparation solution, 5 g of sample was taken and completed to 100 mL with water. It was stirred and heated at 60°C for 1 hour in water bath. The solution was transferred to volumetric flask and made up 250 mL with distilled water. 15 mL was taken from the solution into conical flask and 5 mL (37%) hydrochloric acid added to it. The conical flask was covered with aluminum foil and put it in oven at 69°C for 1 hour in a dark place. Then a little water was added to the solution and pH was adjusted to 6-8 by 0.1M NaOH. 1 ml of each reagent (carrez I and II) were added to the solution and completed to 100 mL in volumetric flask with water, and then it was filtered and put into burette. About 15 mL was taken from burette and 10 mL of the Fehling’s solution was added to conical flask and boiled, when it was stared to boil, added methylene blue. At the end, the solution was titrated with super solution in the burrete. Total sugar was calculated using the following Equation:

$$\text{mg Reducing sugar in 100 (ml)} = \frac{\text{total reducing sugar required}}{\text{Titer (ml)}} \times 100 \quad \text{……… Eq. 3.3}$$

$$\text{Total sugar (\%)} = \frac{\text{total reducing sugar required} \times \text{dilution factor} \times 1000}{\text{titer (ml)} \times \text{weight of sample} \times 100} \quad \text{…… Eq. 3.4}$$

3.5.7 Determination of Fat Content

The fat determination was carried out by extracting samples with hexane (AOAC, 1990). About 5g of the sample was weighted and put in extraction thimble. 2 or 3 boiling beads put into extraction flask and it was dried in oven and weighted. 50 ml hexane was added into extraction flask. The extraction thimble and extraction flask were put in the instrument. The sample was held 45 min for boiling in hot water at 180°C, rinsing in cold solvent 20 min and the solvent was recovered for 10 min. The extraction flask was taken out and weighed after cooling it at room temperature in a desiccator.

3.5.8 Determination of Ash Content

About 1g of the sample was taken and put in a crucible for ash content analysis. Ash content was determined by burning at 900°C until constant weight reached (AOAC, 1990). Then the crucibles were taken out of the oven and were weighed after cooling them at room temperature in a desiccator.

3.5.9 Sensory Analysis

10 individuals (untrained judges) were interviewed in order to make testing on the manna bar samples. The opinion of the judges was requested with regard to texture and flavor of each sample. Using the following scale: as 1 (worst) to 10 (best). The overall sensory quality of manna bars was followed from Eq. (3.5) (Bozkurt & Erkmen, 2004) as:

Overall Sensory Quality=(texture x 0.5)+(flavor x 0.5) ……………………..….   3.5

3.6 Statistical Analysis

ANOVA was performed to determine significant differences at $\alpha = 0.95$. Duncan Post Hoc test was also carried out.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Moisture Content

The moisture contents of manna bars after producing at different processes and recipes, and some commercial manna bars were determined. Their results are given in Tables 4.1- 4.7. Generally, increasing cooking temperature, cooking time, and mixing time decreased ($P<0.05$) the moisture content. However, increasing amount of egg white increased ($P<0.05$) the moisture content.

The moisture content of manna bar was followed at 100, 110 and 120°C for different cooking time (5, 10, and 15) and mixing time (10, 20, and 30 min). Their results are given in Tables 4.1- 4.3. The reduction of moisture content of samples cooked at 100°C for 5 min was not affected significantly ($P>0.05$) by different mixing time. At 10 min cooking time, at the same temperature, the increase of mixing time from 10 to 20 min, moisture content was not significantly affected ($P>0.05$). However, increasing mixing time to 30 min at 10 min cooking time, moisture content decreased significantly ($P<0.05$). At 15 min cooking time, the moisture content decreased significantly ($P<0.05$) between 10 and 20 min mixing time but it was not significant ($P>0.05$) at 30 min mixing time. However, cooking of manna bar at 110°C, the moisture content was not significant ($P>0.05$) at 5 and 15 min cooking time by increasing mixing time, but it decreased significantly ($P<0.05$) at 10 min cooking time. The moisture content of manna bar was found at 120°C for 5 min cooking time the moisture content decreased but not significantly ($P>0.05$) between at 10 and 20 min mixing time, but it was significant ($P<0.05$) for 30 min mixing time. The reduction of moisture content of samples was significant ($P<0.05$) at 10 min cooking time by increasing mixing time. At 15 min cooking time, the moisture content of samples decreased significantly ($P<0.05$) from 10 to 20 min mixing time, but it was not significant ($P>0.05$) for 30 min cooking time.

Table 4.1 Changes in moisture content and pH in manna bar at 100°C for different cooking time and mixing time.

Cooking time	Mixing time	Moisture content (%)	pH
5 min	10 min	15.58 ±0.03^{a}	5.84 ±0.09^{a}
	20 min	15.45 ±0.15^{a}	5.84 ±0.08^{a}
	30 min	15.34 ±0.42^{a}	5.84 ±0.08^{a}
10 min	10 min	15.26 ±0.11^{A}	5.59 ±0.06^{A}
	20 min	14.96 ±0.10^{A}	6.24 ±0.00^{B}
	30 min	13.25 ±0.12^{B}	6.33 ±0.05^{B}
15 min	10 min	13.89 ±0.23^{X}	5.92 ±0.08^{X}
	20 min	13.56 ±0.16^{XY}	6.17 ±0.03^{Y}
	30 min	13.11 ±0.91^{Y}	6.43 ±0.06^{Z}

Small letters (a,b,c) show significant difference mixing time at (α = 0.05) for at 5 min of cooking time for each parameter.
Capital letters (A,B,C)show significant difference mixing time at (α = 0.05) for 10 min of cooking time for each parameter.
Capital letters (X,Y,Z) show significant difference mixing time at (α = 0.05) for 15 min of cooking time for each parameter.
± Standard deviation

Table 4.2 Changes in moisture content and pH in manna bar at 110°C for different cooking time and mixing time.

Cooking time	Mixing time	Moisture content (%)	pH
5 min	10 min	13.42 ±0.32^{a}	5.65 ±0.06^{a}
	20 min	13.07 ±0.53^{a}	6.20 ± 0.07^{b}
	30 min	12.46 ±0.42^{a}	6.32 ±0.03^{b}
10 min	10 min	13.20 ±0.11^{A}	6.02 ±0.00^{A}
	20 min	12.60 ±0.09^{B}	6.20 ±0.03^{B}
	30 min	11.16 ±0.07^{C}	6.40 ±0.03^{C}
15 min	10 min	11.64 ±0.43^{X}	6.15 ±0.05^{X}
	20 min	11.40 ±0.17^{X}	6.30 ±0.04^{Y}
	30 min	10.43 ±0.32^{X}	6.51 ±0.03^{Z}

Small letters (a,b,c) show significant difference mixing time at (α = 0.05) for at 5 min of cooking time for each parameter.
Capital letters (A,B,C)show significant difference mixing time at (α = 0.05) for 10 min of cooking time for each parameter.
Capital letters (X,Y,Z) show significant difference mixing time at (α = 0.05) for 15 min of cooking time for each parameter.
± Standard deviation

Table 4.3 Changes in moisture content and pH in manna bar at 120°C for different cooking time and mixing time

Cooking time	mixing time	Moisture content (%)	pH
5 min	10 min	11.06 ±0.18^{a}	6.06 ±0.12^{a}
	20 min	10.45 ±0.28^{a}	6.16 ±0.05^{a}
	30 min	9.41 ±0.16^{b}	6.29 ±0.00^{a}
10 min	10 min	10.71 ±0.15^{A}	6.05 ±0.02^{A}
	20 min	10.04 ±0.09^{B}	6.06 ±0.02^{A}
	30 min	9.58 ±0.06^{C}	6.30 ±0.00^{B}
15 min	10 min	9.21 ±0.04^{X}	5.91 ±0.07^{X}
	20 min	8.64 ±0.06^{Y}	6.00 ±0.03^{XY}
	30 min	8.50 ±0.07^{Y}	6.10 ±0.00^{Y}

Small letters (a,b,c) show significant difference mixing time at (α = 0.05) for at 5 min of cooking time for each parameter.
Capital letters (A,B,C)show significant difference mixing time at (α = 0.05) for 10 min of cooking time for each parameter.
Capital letters (X,Y,Z) show significant difference mixing time at (α = 0.05) for 15 min of cooking time for each parameter.
± Standard deviation

Generally, high temperature, long cooking time and mixing time affected the moisture content. The reduction of moisture content in manna bar could be due to the evaporation of water by high temperature and long time. Jeffery (2001) mentioned that moisture content ranges from 6% in hard nougats to 15–17% in soft nougats.

Hojjati et al. (2015) studied moisture content of two Spanish turrón cooked for one hour at 50-60°C, then cooked again for one more hour at 70-80°C. They reported that moisture content was obtained 5.02% and 4.28% for first and second cooking respectively. Also, the moisture content of two French nougats was found which were cooked for 12 hours at 35°C as 4.83% and 5.90.

The moisture content of manna bar was followed at 120°C for 15 min cooking time having different amount of egg white (2.5, 4.0, 5.5, and 7.0%), and at different mixing time of (5, 10, and 20 min) during the processing, the results are given in Table 4.4. Between 5 min and 10 min of mixing time at 2.5 and 4.0% of egg white, the moisture content of samples decreased but not significantly (P>0.05), however, at

20 min mixing time, they were significant (P<0.05). Increasing the mixing time at 5.5, 7.0% of egg white decreased (P<0.05) moisture content of samples. The lowest moisture content was obtained at the 2.5% of egg white and at 20 min mixing time. Adding of egg white increased moisture content due to the high water content of egg white (egg white consists of about 90% water).

Table 4.4 Changes in moisture content and pH in manna bar at 120°C for 15 min cooking time for different mixing time and amount of egg white.

Egg white%	Mixing time	Moisture content (%)	pH
2.5	5 min	6.03 ±0.29^{a}	5.94 ±0.04^{a}
	10 min	5.82 ±0.09^{a}	5.94 ±0.012^{a}
	20 min	4.84 ±0.15^{b}	6.04 ±0.05^{b}
4.0	5 min	7.61 ±0.14^{A}	5.93 ±0.02^{A}
	10 min	7.26 ±0.11^{A}	5.95 ±0.05^{A}
	20 min	6.60 ±0.10^{B}	6.06 ±0.03^{B}
5.5	5 min	8.03 ±0.12^{D}	5.94 ±0.00^{D}
	10 min	7.64 ±0.07^{E}	6.00 ±0.02^{E}
	20 min	7.27 ±0.06^{F}	6.12 ±0.02^{F}
7.0	5 min	8.97 ±0.09^{X}	6.09 ±0.05^{X}
	10 min	8.37 ±0.13^{Y}	6.11 ±0.04^{X}
	20 min	8.21 ±0.05^{Z}	6.19 ±0.02^{X}

Small letters (a,b,c) show significant difference (α=0.05) at mixing time for 2.5% of egg white for each parameter.
Capital letters (A,B,C) show significant difference (α=0.05) at mixing time for 4% of egg white for each parameter.
Capital letters (D,E,F) show significant difference (α=0.05) at mixing time for 5.5% of egg white for each parameter.
Capital letters (X,Y,Z) show significant difference (α=0.05) at mixing time for 7% of egg white for each parameter.
E: Sample of egg white
± Standard deviation

The moisture content of manna bar was followed at 120°C for 15 min cooking time and 30 min mixing time for different amount of pistachio (15, 25, 35, and 45%). The results are given in Table 4.5. The lowest moisture content observed at high amount of pistachios and increasing the amount of pistachio which added into manna bar decreased (P<0.05) moisture content. This could be due to the pistachio had lower moisture content than that of the manna bar. Vázquez et al. (2006) found the moisture content for 3 samples of a typical Spanish confectionery product "xixona turron” as affected by commercial category and manufacturing company. The moisture content were obtained 4.68, 2.61 and 2.36% , they contained 54.31, 59.44 and 60.30% almond, respectively. They concluded that moisture content decreased by adding almond.

Table 4.5 Changes in moisture content and pH in manna bar at 120°C for 15 min cooking time and 30 min mixing time at different percentage of pistachio

Sample	Pistachio (%)	Moisture content (%)	pH
P1	15	7.99 ±0.08[a]	5.77 ±0.02[a]
P2	25	7.28 ±0.09[b]	5.78 ±0.04[a]
P3	35	6.41 ±0.23[c]	5.76 ±0.02[a]
P4	45	5.17 ±0.03[d]	5.81 ±0.06[a]

Small letters (a,b,c,d) show significant difference (α=0.05) at different percentage of pistachio for each parameter.
P: sample.
± Standard deviation

The moisture contents for 10 commercial samples of manna bar without nuts and 10 samples with pistachio in the commercial product were found and their results are given in Tables 4.6 and 4.7. The lowest moisture content in manna bars without nuts was obtained as 8.64% in S5 and the highest was obtained 12.69% in sample S8 as shown in Table 4.6. Among the commercial samples with pistachio, the lowest moisture content was obtained 7.18% in PS10, and the highest was obtained 10.29% in PS5 as shown in Table 4.7. Generally, the moisture content of samples with pistachio was lower than those without nuts. It could be because of two reasons. First, the moisture content of pistachio was lower than that of manna bar, it caused to reduce moisture content in the final product. Second, when pistachio was added to the mixture of manna bar, it needed more mixing time; hence more water was lost by evaporation. In all samples, there were different moisture contents. Temperature and time were the main effects on the moisture content. Also, the ingredients had effects on the moisture content of manna bar.

The moisture content of manna bar in this study was higher than the samples reported in literature such as two samples of Spanish turrón were 5.02% and 4.28%, two samples of French nougat which were 4.83% and 5.90%, and two samples of Italian torrone were 3.69% and 2.84% (Hojjati et al., 2015). The low moisture content could be related to a long time heating, the processes was referred in (2.5.1.1.- 2.5.1.3.) section.

Table 4.6 Changes in moisture content and pH in manna bar without nuts at different brand of company.

Samples	Moisture content (%)	pH
S1	10.49 ±0.38	5.44 ±0.02
S2	11.35 ±0.16	5.64 ±0.03
S3	9.68 ±0.17	4.90 ±0.05
S4	8.80 ±0.13	5.12 ±0.03
S5	8.64 ±0.09	5.31 ±0.00
S6	9.23 ±0.05	4.12 ±0.04
S7	12.51 ±0.09	5.04 ±0.00
S8	12.69 ±0.23	5.62 ±0.04
S9	11.98 ±0.26	4.56 ±0.02
S10	11.44 ±0.38	6.00 ±0.03

S: Samples without nuts at different brand of company.
± Standard deviation

Table 4.7 Changes in moisture content and pH in Manna bar with pistachio at different brand of company.

samples	Moisture content (%)	PH
PS1	8.93 ±0.18	5.72 ±0.02
PS2	9.87 ±0.53	5.65 ±0.07
PS3	9.41 ±0.24	5.65 ±0.06
PS4	7.36 ±0.36	4.98 ±0.00
PS5	10.29 ±0.27	5.73 ±0.05
PS6	9.26 ±0.09	5.60 ±0.05
PS7	9.29 ±0.01	5.71 ±0.03
PS8	10.10 ±0.29	5.55 ±0.02
PS9	8.84 ±0.07	4.92 ±0.02
PS10	7.18 ±0.23	5.11 ±0.11

S: Samples contain pistachio at different brand of company.
± Standard deviation

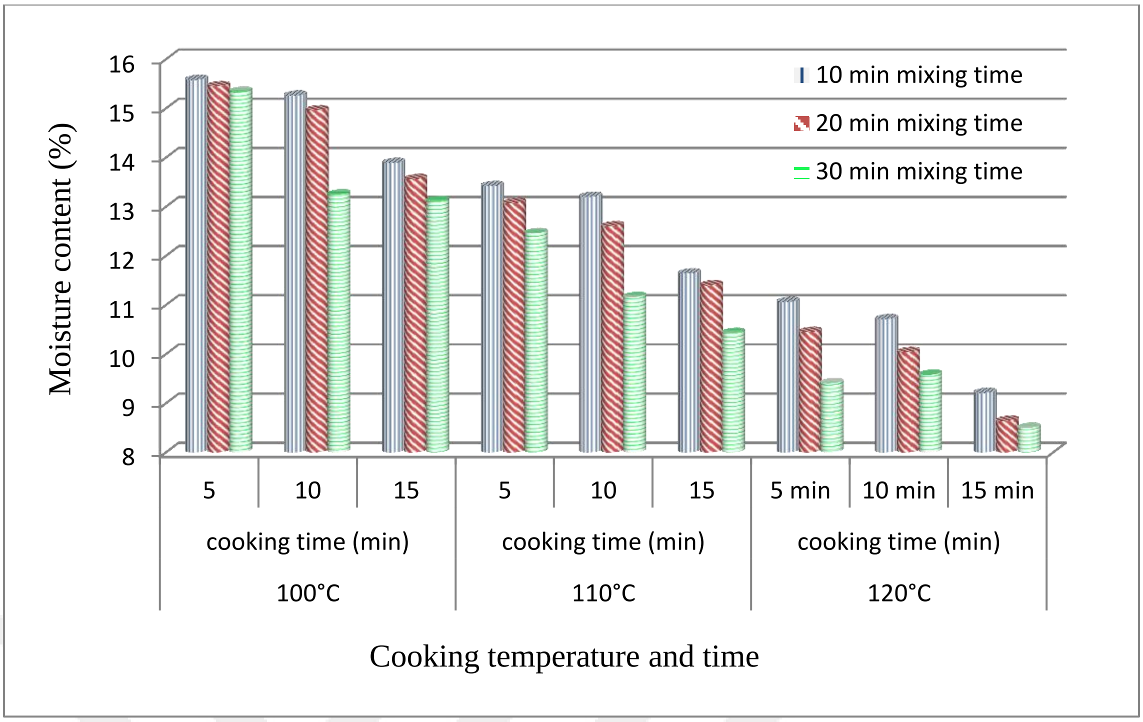

Figure 4.1 Changes in moisture content in manna bar at different temperature, cooking time and mixing time

The Figure 4.1 showed that the best moisture content of manna bar produced in this study was in the range of 8.50 – 9.21%, according to commercial products.

4.2 pH Value

The changes in pH value were carried out during producing of manna bar at different processes and the recipes.

The pH value of manna bar was followed at 100, 110 and 120°C for different cooking times (5, 10, and 15) and mixing times (10, 20, and 30 min). Their results are given in Tables 4.1-4.3. At 100°C for 5 min cooking time, the pH value was not changed ($P>0.05$) with increasing mixing time. At 10 min cooking time at that temperature, the pH value increased ($P<0.05$) from 10 to 20 min mixing time, but not significantly affected ($P>0.05$) at 30 min mixing time. At 15 min cooking time, the pH value increased ($P<0.05$) by increasing mixing time. At 110°C for different cooking time, the pH value increased ($P<0.05$) by mixing time, except between 20 and 30 min at mixing time, it was not significant ($P>0.05$) at 5 min cooking time. At

120°C, increasing mixing time, the pH value increased and was not significant ($P>0.05$) at 5 min cooking time. At 10 min cooking time for 10 and 20 min mixing time, the pH value was not affected significantly ($P>0.05$) however, it was significant ($P<0.05$) at 30 min mixing time. At 15 min cooking time, the pH value increased ($P<0.05$) from 10 to 20 min mixing time. However, it was not significant ($P>0.05$) at 30 min mixing time.

The pH value of manna bar was followed at 120°C for 15 min cooking time, at different amount of egg white (2.5, 4.0, 5.5, and 7.0%), and at different mixing time (5, 10, and 20 min) during the processing, the results are given in Table 4.4. The pH value in 2.5% egg white containing samples was not changed significantly ($P>0.05$) from 5 to 10 min mixing time, but at 20 min mixing time the pH value increased significantly ($P<0.05$). The pH value in 4.0% egg white increased but not significantly ($P>0.05$) between 5 and 10 min mixing time. Also, the result showed that it was significant ($P<0.05$) at 20 min mixing time. The pH value in 5.5% egg white increased and significantly ($P<0.05$) at different mixing time. The pH value in 7.0% egg white increased but not significantly ($P>0.05$) by increasing mixing time. In this part, between 5 and 10 min, there was not a difference. But for 20 min mixing time there was a difference because the long mixing time could cause the loss of water by evaporation.

Generally, the pH value increased ($P<0.05$) during mixing time. The temperature of manna bar decreased during the mixing time, this would lead to decrease the ability of water to ionize, and so the concentration of $H+$ in manna bars would decrease, hence it could decrease the pH.

The pH value of manna bar was determined at different amount pistachio (15, 25, 35, and 45%) at 120°C, 15 min cooking time, and 30 min mixing time. The results are given in Table 4.5. The pH value was not significantly affected ($P>0.05$) at different amount of pistachio. This could be due to the pH of pistachio close to the pH value of the samples.

The pH value was found for 10 samples of manna bar without nuts and 10 samples which contained pistachio. Between the ranges 4.12-6.0 the pH values were found, their results are given in Tables 4.6. and 4.7. The pH values were different between the samples, they related to different recipes and processes. Manna bar was prepared in this study, had higher pH value than the commercial samples, because some factories added citric acid during cooking.

4.3 Color Measurement

The Hunter L*, a*, b* values of the manna bar were measured to determine the change in color of manna bar after producing at different processes and recipes. L* (lightness-darkness), a* (redness-greenness), b* (yellowness-blueness) have been previously proved valuable in describing deterioration of visual colour (Garza et al., 1999; Gunawan and Barringer 2000; Tijskens et al., 2001). Browning index (BI) values were calculated by use of Hunter L*, a*, and b* values (Bayram and Bozkurt, 2007).

The color value of manna bar was followed at 100, 110 and 120°C for different cooking time (5, 10, and 15) and mixing time (10, 20, and 30 min). Their results are given in Tables 4.8.-4.10. The Hunter L* value increased significantly ($P<0.05$) at different cooking temperature, cooking time and mixing time, except at 30 min mixing time for 15 min cooking at 120°C. However, the Hunter a*, b*, YI and Browning index (BI) values decreased significantly ($P<0.05$) during the processes. Generally, during the mixing, manna bar was going to be white due to that manna bar took air during mixing time.

Table 4.8 Determination color in manna bar at 100°C for different cooking time and mixing time

Cooking time	Mixing time	CIE L*	CIE a*	CIE b*	CIE YI	BI
5 min	10 min	67.57 ±0.14[a]	4.89 ±0.04[a]	13.58 ±0.06[a]	39.18 ±0.11[a]	27.34 ±0.08[a]
	20 min	70.04 ±0.00[b]	3.76 ±0.00[b]	10.95 ±0.04[b]	29.09 ±0.07[b]	20.60 ±0.07[b]
	30 min	75.79 ±0.28[c]	2.96 ±0.00[c]	9.89 ±0.01[c]	35.73 ±0.09[c]	16.54 ±0.09[c]
10 min	10 min	65.53 ±0.10[A]	4.88 ±0.01[A]	13.27 ±0.15[A]	37.16 ±0.01[A]	27.69 ±0.31[A]
	20 min	74.18 ±0.20[B]	3.85 ±0.00[B]	11.14 ±0.05[B]	28.36 ±0.03[B]	19.76 ±0.03[B]
	30 min	84.42 ±0.60[C]	2.80 ±0.05[C]	8.79 ±0.02[C]	20.32 ±0.01[C]	13.18 ±0.02[C]
15 min	10 min	68.47 ±0.09[X]	4.66 ±0.01[X]	12.96 ±0.00[X]	34.83 ±0.01[X]	25.59 ±0.00[X]
	20 min	75.14 ±0.04[Y]	3.85 ±0.00[Y]	11.15 ±0.00[Y]	28.11 ±0.02[Y]	19.50 ±0.01[Y]
	30 min	78.77 ±0.29[Z]	2.67 ±0.03[Z]	8.30 ±0.02[Z]	20.43 ±0.07[Z]	13.37 ±0.01[Z]

Small letters (a,b,c) show significant difference (α = 0.05) at mixing time for 5 min of cooking time for each parameter.
Capital letters (A,B,C)show significant difference (α = 0.05) at mixing time for 10 min of cooking time for each parameter.
Capital letters (X,Y,Z) show significant difference (α = 0.05) mixing time for 15 min of cooking time for each parameter.
± Standard deviation

Table 4.9 Determination color in manna bar at 110°C for different cooking time and mixing time

Cooking time	Mixing time	CIE L*	CIE a*	CIE b*	CIE YI	BI
5 min	10 min	66.66 ±0.21[a]	4.71 ±0.00[a]	13.02 ±0.02[a]	35.69 ±0.09[a]	26.53 ±0.11[a]
	20 min	75.83 ±0.00[b]	3.92 ±0.00[b]	11.72 ±0.04[b]	29.06 ±0.09[b]	20.25 ±0.07[b]
	30 min	81.90 ±0.02[c]	2.61 ±0.02[c]	8.13 ±0.03[c]	19.37 ±0.04[c]	12.57 ±0.03[c]
10 min	10 min	68.88 ±0.10[A]	4.39 ±0.00[A]	12.83 ±0.01[A]	34.06 ±0.06[A]	24.90 ±0.05[A]
	20 min	77.38 ±0.13[B]	3.05 ±0.00[B]	9.40 ±0.03[B]	23.23 ±0.04[B]	15.56 ±0.02[B]
	30 min	79.32 ±0.26[C]	2.31 ±0.04[C]	7.44 ±0.03[C]	18.20 ±0.05[C]	11.76 ±0.04[C]
15 min	10 min	74.44 ±0.00[X]	3.96 ±0.02[X]	12.49 ±0.03[X]	13.01 ±0.04[X]	21.91 ±0.02[X]
	20 min	77.66 ±0.02[Y]	2.83 ±0.02[Y]	9.32 ±0.01[Y]	22.8 ±0.01[Y]	15.18 ±0.00[Y]
	30 min	83.17 ±0.25[Z]	2.20 ±0.02[Z]	7.76 ±0.02[Z]	17.99 ±0.00[Z]	11.50 ±0.01[Z]

Small letters (a,b,c) show significant difference (α = 0.05) at mixing time for 5 min of cooking time for each parameter.
Capital letters (A,B,C)show significant difference (α = 0.05) at mixing time for 10 min of cooking time for each parameter.
Capital letters (X,Y,Z) show significant difference (α = 0.05) mixing time for 15 min of cooking time for each parameter.
± Standard deviation

Table 4.10 Determination color in manna bar at 120°C for different cooking time and mixing time

Cooking time	Mixing time	CIE L*	CIE a*	CIE b*	CIE YI	BI
5 min	10	71.13 ±0.04[a]	2.61 ±0.01[a]	10.44 ±0.04[a]	26.51 ±0.08[a]	18.23 ±0.03[a]
	20	82.92 ±0.00[b]	2.26 ±0.00[b]	9.57 ±0.02[b]	21.57 ±0.05[b]	13.99 ±0.04[b]
	30	84.89 ±0.13[c]	2.00 ±0.04[c]	8.62 ±0.03[c]	19.17 ±0.00[c]	12.19 ±0.01[c]
10 min	10	76.00 ±0.10[A]	2.59 ±0.04[A]	11.65 ±0.02[A]	27.51 ±0.02[A]	18.79 ±0.03[A]
	20	75.60 ±0.05[A]	2.25 ±0.01[B]	10.02 ±0.02[B]	24.08 ±0.01[B]	16.10 ±0.04[B]
	30	78.21 ±0.28[B]	1.93 ±0.00[C]	8.96 ±0.06[C]	21.05 ±0.04[C]	13.70±0.03[C]
15 min	10	75.40 ±0.14[X]	2.33 ±0.00[X]	12.84 ±0.09[X]	29.76 ±0.21[X]	20.55 ±0.11[X]
	20	78.14 ±0.25[Y]	1.97 ±0.05[Y]	11.45 ±0.04[Y]	25.94 ±0.03[Y]	17.36 ±0.04[Y]
	30	76.92 ±0.10[Z]	1.74 ±0.00[Z]	10.72 ±0.02[Z]	24.59 ±0.04[Z]	16.35 ±0.03[Z]

Small letters (a,b,c) show significant difference (α = 0.05) at mixing time for 5 min of cooking time for each parameter.
Capital letters (A,B,C)show significant difference (α = 0.05) at mixing time for 10 min of cooking time for each parameter.
Capital letters (X,Y,Z) show significant difference (α = 0.05) mixing time for 15 min of cooking time for each parameter.
± Standard deviation

The color of manna bar was followed at 120°C for 15 min cooking time, at different amount of egg white (2.5, 4.0, 5.5, and 7.0%), and at different mixing times (5, 10, and 20 min) during the processing. The results are given in Table 4.11. The Hunter L* values in sample containing 2.5% egg white increased significantly ($P<0.05$) from 5 to 10 min mixing time, but it was not significantly affected ($P>0.05$) at 20 min mixing time. The Hunter L* values in 4.0, 5.5 and 7.0% of egg white increased significantly ($P<0.05$) by increasing mixing time, but the Hunter L*-value decreased at 20 min mixing time at 7.0% of egg white. Reducing Hunter a*, b*, YI and Browning index (BI) at different amount of egg white was significant ($P<0.05$) by increasing mixing time. In this part, the manna bar was going to be white by increasing egg white in almost all the samples; it could be due to the precipitation of egg albumin.

The color of manna bar was followed at 120°C for 15 min cooking time and 30 mixing time, for different amount of pistachio (15, 25, 35, and 45%). The results are given in Table 4.12. The Hunter L*-values decreased significantly ($P<0.05$), however, the Hunter b*, YI and Browning index (BI) increased significantly ($P<0.05$) by increasing amount of pistachio. The Hunter a* was not significant ($P>0.05$) at 15, 25 and 35% of pistachio, but it increased significantly ($P<0.05$) at 45% of pistachio. Near yellow color pistachio was used for manna bar production, which increase b* values. Hence they could cause to decrease L*-value and increase BI.

Color (Hunter L*, a*, and b* values) of commercial manna bar were determined in 10 samples of manna bar without nuts and 10 samples with pistachio in commercial products. The results are given in Table 4.13 and 4.14. There was a different color observed in all commercial samples that could be due to the different recipes, especially, the amount of egg white and manna, so their amounts affected the final product color. Also, temperature and time for cooking and mixing could be different in those commercial samples.

Table 4.11 Color determination in manna bar at 120°C for 15 min cooking time for different mixing time and amount of egg white

Egg white	Mixing time	CIE L*	CIE a*	CIE b*	CIE YI	BI
2.50%	5 min	70.47 ±0.38^{a}	2.85 ±0.05^{a}	15.09 ±0.13^{a}	36.18 ±0.05^{a}	26.60 ±0.00^{a}
	10 min	77.82 ±0.07^{b}	2.62 ±0.01^{b}	14.89 ±0.03^{a}	33.04 ±0.12^{b}	23.28 ±0.05^{b}
	20 min	77.90 ±0.00^{b}	2.29 ±0.07^{c}	13.35 ±0.48^{a}	30.18 ±0.55^{c}	20.57 ±0.56^{c}
4.00%	5 min	68.10 ±0.07^{A}	3.94 ±0.00^{A}	17.63 ±0.01^{A}	43.30 ±0.07^{A}	33.66 ±0.04^{A}
	10 min	78.94 ±0.09^{B}	3.53 ±0.02^{B}	16.56 ±0.00^{B}	36.64 ±0.07^{B}	26.38 ±0.04^{B}
	20 min	82.86 ±0.11^{C}	2.36 ±0.00^{C}	12.61 ±0.01^{C}	27.27 ±0.04^{C}	18.25 ±0.02^{C}
5.00%	5 min	73.78 ±0.20^{D}	3.34 ±0.05^{D}	14.63 ±0.06^{D}	34.68 ±0.18^{D}	25.00 ±0.16^{D}
	10 min	75.28 ±0.08^{E}	2.74 ±0.01^{F}	12.99 ±0.04^{E}	30.47 ±0.09^{E}	21.23 ±0.04^{E}
	20 min	84.55 ±0.09^{F}	2.16 ±0.00^{F}	10.70 ±0.03^{F}	23.22 ±0.04^{F}	15.11 ±0.02^{F}
7.00%	5 min	71.71 ±0.05^{X}	3.87 ±0.01^{X}	15.63 ±0.05^{X}	37.94 ±0.12^{x}	28.09 ±0.07^{X}
	10 min	86.68 ±0.38^{Y}	3.23 ±0.01^{Y}	13.93 ±0.08^{Y}	32.30 ±0.28^{y}	22.74 ±0.17^{Y}
	20 min	82.30 ±0.04^{Z}	2.29 ±0.02^{Z}	10.57 ±0.00^{Z}	23.61 ±0.02^{Z}	15.84 ±0.01^{Z}

Small letters (a,b,c) show significant difference ($\boldsymbol{\alpha}$=0.05) at mixing time for 2.5% of egg white for each parameter.
Capital letters (A,B,C) show significant difference ($\boldsymbol{\alpha}$=0.05) at mixing time for 4% of egg white for each parameter.
Capital letters (D,E,F) show significant difference ($\boldsymbol{\alpha}$=0.05) at mixing time for 5.5% of egg white for each parameter.
Capital letters (X,Y,Z) show significant difference ($\boldsymbol{\alpha}$=0.05) at mixing time for 7% of egg white for each parameter.
± Standard deviation

Table 4.12 Color determination in manna bar at 120°C for 15 min cooking time and 30 min mixing time for different amount of pistachio

Sample	pistachio %	CIE L*	CIE a*	CIE b*	CIE YI	BI
P1	15	60.85 ±0.44[a]	4.66 ±0.15[a]	24.79 ±0.32[a]	62.13 ±0.64[a]	56.70 ±0.49[a]
P2	25	59.12 ±0.37[b]	4.59 ±0.19[a]	26.89 ±0.78[b]	63.16 ±0.32[ab]	64.65 ±1.43[b]
P3	35	57.96 ±0.07[c]	4.42 ±0.06[a]	29.27 ±0.54[c]	64.11 ±0.02[b]	73.41 ±1.51[c]
P4	45	56.55 ±0.21[d]	5.41 ±0.17[b]	31.88 ±0.46[d]	67.14 ±0.43[c]	86.21 ±1.76[d]

The letters (a,b,c,d) show significant difference (α=0.05) at different amount of pistachio for each parameter.
± Standard deviation

Table 4.13 Color determination in Manna bar without nuts at different brand of company.

sample	CIE L*	CIE a*	CIE b*	CIE YI	BI
S1	64.06 ±0.40	3.56 ±0.02	18.39 ±0.08	46.21 ±0.29	37.28 ±0.38
S2	62.21 ±0.50	3.77 ±0.07	15.73 ±0.05	42.15 ±0.38	33.08 ±0.36
S3	74.95 ±0.15	1.04 ±0.00	9.58 ±0.03	22.06 ±0.09	14.39 ±0.07
S4	66.13 ±0.14	1.81 ±0.03	13.88 ±0.04	34.29 ±0.05	25.08 ±0.02
S5	61.67 ±0.19	2.65 ±0.01	15.93 ±0.03	41.38 ±0.15	32.45 ±0.18
S6	61.57 ±0.18	2.39 ±0.00	15.78 ±0.03	40.80 ±0.02	31.88 ±0.02
S7	61.22 ±0.19	3.29 ±0.02	15.99 ±0.06	42.58 ±0.18	33.65 ±0.18
S8	63.18 ±0.34	3.35 ±0.03	16.21 ±0.05	42.15 ±0.09	32.99 ±0.15
S9	61.17 ±0.04	2.85 ±0.01	16.77 ±0.09	42.96 ±0.79	34.84 ±0.21
S10	63.53 ±0.05	3.20 ±0.01	17.58 ±0.21	44.41 ±0.39	35.46 ±0.42

S: Samples without nuts at different brand of company.
± Standard deviation

Table 4.14 Color determination in Manna bar with pistachio at different brand of company

Samples	CIE L*	CIE a*	CIE b*	CIE YI	BI
PS1	61.15 ±1.61	0.74 ±0.39	29.54 ±0.87	63.63 ±2.03	64.51 ±5.33
PS2	59.75 ±0.31	1.73 ±0.54	25.75 ±0.54	59.21 ±0.29	56.8 ±0.67
PS3	58.76 ±0.29	1.68 ±0.17	24.98 ±0.66	58.86 ±1.06	55.81 ±1.89
PS4	65.71 ±0.06	1.71 ±0.28	27.64 ±0.78	59.16 ±0.87	54.88 ±1.65
PS5	59.36 ±0.62	1.40 ±0.47	24.57 ±0.05	57.29 ±0.28	53.58 ±0.18
PS6	64.97 ±0.72	0.79 ±0.19	23.32 ±0.65	51.45 ±0.18	44.17 ±0.34
PS7	61.59 ±1.09	0.70 ±0.01	22.92 ±0.77	52.28 ±1.72	46.17 ±3.76
PS8	62.79 ±0.98	1.86 ±0.47	25.35 ±0.98	57.22 ±1.54	52.51 ±3.25
PS9	59.765 ±0.18	3.00 ±0.79	24.46 ±1.98	58.97 ±1.78	55.03 ±4.65
PS10	60.675 ±1.21	4.87 ±0.15	25.51 ±0.02	62.62 ±1.08	59.13 ±1.65

PS: Samples contain pistachio at different brand of company

± Standard deviation

4.4. Texture Analysis Profile

Texture profile analysis (hardness, adhesiveness, springiness, cohesiveness, and chewiness values) of manna bar were found during the production at different processes and recipes, and results are given in Tables 4.15-4.21.

The texture profile analysis of manna bar was followed at 100°C for different cooking times (5, 10, and 15) and mixing times (10, 20, and 30 min), and their results are given in Table 4.15.

Hardness and adhesiveness values of samples increased significantly ($P < 0.05$) at the different cooking times and mixing times, except from 10 to 20 min mixing for 10 min cooking which was not significantly affected ($P > 0.05$) in hardness.

Springiness values at 5 min cooking time decreased significantly ($P < 0.05$) at different mixing times. At 10 and 15 min cooking time, springiness values were not significant ($P > 0.05$) by increasing mixing time.

Cohesiveness values at 5 min cooking time decreased significantly ($P < 0.05$) at 20 min to 10 and 30 min from 10 to 20 min mixing time, cohesiveness values were not significant ($P > 0.05$) for 10 min cooking time, but it was significant ($P < 0.05$) for 30 min mixing. At 15 cooking time cohesiveness was not significant ($P > 0.05$) by mixing time.

Chewiness values in samples decreased significantly ($P < 0.05$) at 5 min cooking time by increasing mixing times. At 10 and 15 min cooking time from 10 to 20 min mixing time of the samples, chewiness decreased but not significantly ($P > 0.05$), and then increased significantly ($P < 0.05$) at the 30 min mixing time.

Table 4.15 Changes in texture in manna bar at 100°C for different cooking time and mixing time

Cooking time	Mixing time	Hardness (g)	Adhesiveness (g.sec)	Springiness (%)	Cohesiveness (%)	Chewiness (g)
5 min	10 min	131.56 ±1.32[a]	-1.05±0.02[a]	0.70 ±0.01[a]	0.30±0.01[a]	28.18 ±1.26[a]
	20 min	140.44 ±1.32[b]	-0.98 ±0.01[b]	0.51±0.00[b]	0.33±0.00[b]	24.31 ±0.38[b]
	30 min	144.70 ± 0.41[c]	-0.31 ±0.00[c]	0.38±0.01[c]	0.28 ±0.00[a]	15.65 ±0.68[c]
10 min	10 min	156.68 ±2.31[A]	-1.02 ±0.00[A]	0.41 ±0.08[A]	0.31 ±0.00[A]	20.59 ±4.09[A]
	20 min	164.15 ±0.82[A]	-0.61 ±0.02[B]	0.35 ±0.00[A]	0.32 ±0.01[A]	18.46 ±1.36[A]
	30 min	243.08 ±12.97[B]	-0.45 ±0.02[C]	0.39 ±0.00[A]	0.37 ±0.01[B]	35.86 ±1.02[B]
15 min	10 min	181.39 ±1.40[X]	-0.97 ±0.01[X]	0.38 ±0.02[X]	0.31 ±0.00[X]	22.37 ±1.92[X]
	20 min	199.15 ±1.81[Y]	-0.60 ±0.02[Y]	0.38 ±0.01[X]	0.29 ±0.00[X]	18.42 ±0.06[X]
	30 min	279.88 ±0.74[Z]	-0.44 ±0.02[Z]	0.31 ±0.04[X]	0.32 ±0.01[X]	34.75 ±5.55[Y]

Small letters (a,b,c) show significant difference (α = 0.05) at mixing time for 5 min of cooking time for each parameter.
Capital letters (A,B,C)show significant difference (α = 0.05) at mixing time for 10 min of cooking time for each parameter.
Capital letters (X,Y,Z) show significant difference (α = 0.05) mixing time for 15 min of cooking time for each parameter.
± Standard deviation

The texture profile analysis of manna bar was followed for at 110°C for different cooking times (5, 10, and 15) and mixing times (10, 20, and 30 min), and their results are given in Table 4.16.

Hardness values of the samples increased by increasing mixing time at the different cooking times. Also, at 5 and 10 min cooking, they were significant ($P < 0.05$), but not significantly affected ($P > 0.05$) at 15 min cooking.

Adhesiveness values at 5 and 10 min cooking of the samples were not significant ($P > 0.05$) at different mixing times. However, adhesiveness values at 15 min cooking time increased between 10 and 20 min mixing, and then it decreased significantly ($P < 0.05$) at 30 min mixing.

Springiness values of the samples between 10 and 20 min mixing time for 5 min cooking decreased significantly ($P < 0.05$), but between 20 and 30 min mixing time, it was not significantly affected ($P > 0.05$). At 10 min cooking springiness values were not significant ($P > 0.05$) for 10 and 20 min mixing time, but in 30 min mixing time springiness values increased significantly ($P < 0.05$). At 15 min cooking springiness values increased significantly ($P < 0.05$) at different mixing times.

Cohesiveness and chewiness values of the samples at 5 min cooking time were not significant ($P > 0.05$) by increasing mixing time. Between 10 and 20 min mixing time for 10 min cooking time cohesiveness and chewiness values were not significant ($P > 0.05$), but between 20 and 30 min mixing time, they were significant ($P < 0.05$). At 15 min cooking time, cohesiveness increased significantly ($P < 0.05$) by increasing mixing time. Chewiness values at 15 min cooking time were not significant ($P > 0.05$) at 10 and 20 min mixing time. However, it was significantly affected ($P < 0.05$) at 30 min mixing time.

Table 4.16 Changes in texture in manna at 110°C for different cooking time and mixing time

Cooking time	Mixing time	Hardness (g)	Adhesiveness (g.sec)	Springiness (%)	Cohesiveness (%)	Chewiness (g)
5 min	10 min	215.04 ±7.51[a]	-0.06 ±0.01[a]	0.45 ±0.02[a]	0.28 ±0.02[a]	27.61 ±1.75[a]
	20 min	296.69 ±3.91[b]	-0.25 ±0.01[a]	0.32 ±0.02[b]	0.28 ±0.00[a]	27.97 ±2.69[a]
	30 min	317.21 ±0.66[c]	-0.00 ±0.43[a]	0.32 ±0.02[b]	0.33 ±0.01[a]	34.32 ±4.65[a]
10 min	10 min	262.65 ±6.27[A]	0.01 ±0.39[A]	0.35 ±0.02[A]	0.30 ±0.02[A]	27.89 ±1.55[A]
	20 min	310.73 ±2.72[B]	-0.30 ±0.00[A]	0.34 ±0.00[A]	0.30 ±0.01[A]	32.66 ±2.58[A]
	30 min	370.73 ±7.73[C]	-0.32 ±0.01[A]	0.40 ±0.01[B]	0.42 ±0.01[B]	65.12 ±6.51[B]
15 min	10 min	301.32 ±0.33[X]	-0.08 ±0.01[X]	0.32 ±0.02[X]	0.31 ±0.01[X]	31.35 ±0.79[X]
	20 min	413.61 ±73.36[X]	-0.02 ±0.00[Y]	0.35 ±0.01[X]	0.35 ±0.00[Y]	51.88 ±11.96[X]
	30 min	433.12 ±0.82[X]	-0.20 ±0.00[Z]	0.42 ±0.00[Y]	0.43 ±0.00[Z]	79.71 ±1.48[Y]

Small letters (a,b,c) show significant difference (α = 0.05) at mixing time for 5 min of cooking time for each parameter.
Capital letters (A,B,C)show significant difference (α = 0.05) at mixing time for 10 min of cooking time for each parameter.
Capital letters (X,Y,Z) show significant difference (α = 0.05) mixing time for 15 min of cooking time for each parameter.
± Standard deviation

The texture profile analysis of manna bar was followed at 120°C for different cooking times (5, 10, and 15) and mixing times (10, 20, and 30 min), and their results are given in Table 4.17.

Hardness value of the samples increased significantly ($P < 0.05$) by increasing mixing times for 5, 10 and 15 min cooking times.

Adhesiveness values of the samples at 5 min cooking time decreased significantly ($P < 0.05$) between 10 and 20 min mixing time, but it was not significant ($P > 0.05$) between 20 and 30 min mixing. At 10 min cooking, adhesiveness values were significantly ($P < 0.05$) decreased then increased during the mixing time. At 15 min cooking time, adhesiveness values of the samples decreased not significantly ($P > 0.05$) between 10 and 20 min mixing time, but at 30 min mixing time it increased significantly ($P < 0.05$).

Springiness values of the samples at 5 and 10 min cooking time, increased significantly ($P < 0.05$) form 10 to 20 min mixing time, but it was not significantly affected ($P > 0.05$) at 30 min mixing. At 15 min cooking time, springiness values were not significant ($P > 0.05$) at different mixing times.

Cohesiveness of the samples increased and was significantly ($P < 0.05$) by increasing mixing time at 5 min cooking. At 10 min cooking time, cohesiveness increased significantly ($P < 0.05$) from 10 to 20 min mixing, but it was not significant ($P > 0.05$) at 30 min mixing. At 15 min cooking time, cohesiveness was not significant ($P > 0.05$) from 10 to 20 min mixing, but at 30 min mixing time it increased significantly ($P < 0.05$).

Chewiness value of the samples at 5 min cooking time increased significantly ($P < 0.05$) at different mixing times. At 10 min cooking time, chewiness values were not significant ($P > 0.05$) from 10 to 20 min mixing time, but it was significant ($P < 0.05$) for 30 min mixing time. At 15 min cooking time, chewiness values were not significantly affected ($P > 0.05$) between 10 and 20 min mixing, whereas it increased significantly ($P < 0.05$) for 30 min mixing time.

Table 4.17 Changes in texture in manna bar at 120°C for different cooking time and mixing time

Cooking time	Mixing time	Hardness (g)	Adhesiveness (g.sec)	Springiness (%)	Cohesiveness (%)	Chewiness (g)
5 min	10 min	383.21 ±4.32[a]	-0.11 ±0.00[a]	0.39 ±0.00[a]	0.40 ±0.00[a]	61.10 ±0.36[a]
	20 min	424.94 ±0.99[b]	-0.26 ±0.00[b]	0.44 ±0.02[ab]	0.44 ±0.00[b]	84.47 ±5.79[b]
	30 min	609.55 ±5.94[c]	-0.28 ±0.00[b]	0.44 ±0.01[b]	0.48 ±0.00[c]	145.96 ±7.54[c]
10 min	10 min	459.64 ±8.26[A]	-0.17 ±0.03[A]	0.36 ±0.03[A]	0.39 ±0.00[A]	66.16 ±6.65[A]
	20 min	488.97 ±3.30[B]	-0.81 ±0.02[B]	0.41 ±0.03[AB]	0.41 ±0.01[AB]	85.34 ±10.23[A]
	30 min	558.55 ±57.08[C]	-0.63 ±0.01[C]	0.45 ±0.00[B]	0.46 ±0.03[B]	118.49 ±2.82[B]
15 min	10 min	656.16 ±43.29[X]	-0.42 ±0.05[X]	0.39 ±0.06[X]	0.45 ±0.01[X]	118.02 ±23.73[X]
	20 min	821.90 ±5.70[Y]	-0.47 ±0.00[X]	0.46 ±0.00[X]	0.46 ±0.00[X]	174.37 ±3.96 [Y]
	30 min	852.57 ±4.62[Y]	-0.05 ±0.04[Y]	0.50 ±0.00[X]	0.50 ±0.00[Y]	215.78 ±5.97[Y]

Small letters (a,b,c) show significant difference (α = 0.05) at mixing time for 5 min of cooking time for each parameter.
Capital letters (A,B,C)show significant difference (α = 0.05) at mixing time for 10 min of cooking time for each parameter.
Capital letters (X,Y,Z) show significant difference (α = 0.05) mixing time for 15 min of cooking time for each parameter.
± Standard deviation

The texture profile analysis of manna bar was followed at 120°C for 15 min cooking time and 30 mixing time, for a different amount of egg white (2.5, 4.0, 5.5, and 7.0%). The results are given in Table 4.17.

Hardness values of the samples increased significantly ($P < 0.05$) by increasing mixing time at different amount of egg white, except between 10 and 20 min mixing time which was not significant ($P > 0.05$) at 5.5% of egg white . The hardness values reduced by increasing egg white, it could be due to the gelatinization of protein and high water content.

Adhesiveness values could not be determined in samples during the cooking of manna bar at 120°C.

Springiness values in samples containing 2.5% of egg white decreased significantly ($P < 0.05$) for different mixing time. The springiness increased then decreased by increasing mixing time at 4.0, 5.5 and 7.0%, but not significantly ($P > 0.05$).

Cohesiveness values of samples were not significant ($P > 0.05$) between 5 and 10 min mixing time for 2.5% of egg white, but it decreased at 20 min mixing time significantly ($P < 0.05$). At 4.0% of egg white, cohesiveness values increased then decreased during mixing time significantly ($P < 0.05$). At different mixing time, in 5.5 and 7.0% of egg white containing samples the same previous result for increasing and decreasing of values were observed. It was significant ($P < 0.05$) at 5.5% of egg white, but not significantly affected ($P > 0.05$) at 7.0% of egg white.

Chewiness value of the samples was not significant ($P > 0.05$) by increasing mixing time for 2.5 and 7.0% of egg white. At 4.0% of egg white chewiness increased significantly ($P < 0.05$) at different mixing time. At 5.5% of egg white, chewiness values increased significantly ($P < 0.05$) between 5 and 10 min mixing time, but not significant ($P > 0.05$) between 5 and 20 min mixing time.

Table 4.18 Texture analysis in manna bar at 120°C for 15 min cooking time for different mixing time and amount of egg white

Egg white	Mixing time	Hardness (g)	Adhesiveness (g.sec)	Springiness (%)	Cohesiveness (%)	Chewiness (g)
2.5%	5 min	1538.24 ±67.49^{a}	N.D.	0.55 ±0.00^{a}	0.57 ±0.01^{a}	484.85 ±36.22^{a}
	10 min	2012.20 ±171.84^{b}	N.D.	0.52 ±0.01^{b}	0.57 ±0.00^{a}	604.05 ±66.06^{a}
	20 min	2660.01 ±61.21^{c}	N.D.	0.46 ±0.00^{c}	0.49 ±0.01^{b}	611.02 ±3.00^{a}
4%	5 min	758.75 ±8.09^{A}	N.D.	0.40 ±0.03^{A}	0.45 ±0.01^{AB}	140.83 ±15.45^{A}
	10 min	820.32 ±0.49^{B}	N.D.	0.45 ±0.06^{A}	0.47 ±0.00^{B}	175.59 ±30.24^{AB}
	20 min	1222.72 ±24.27^{C}	N.D.	0.41 ±0.01^{A}	0.42 ±0.00^{A}	216.55 ±15.85^{B}
5.5%	5 min	594.47 ±17.68^{D}	N.D.	0.40 ±0.01^{D}	0.44 ±0.00^{D}	108.57 ±8.47^{D}
	10 min	753.08 ±28.99^{E}	N.D.	0.41 ±0.00^{D}	0.48 ±0.01^{E}	150.85 ±1.55^{E}
	20 min	825.31 ±19.80^{E}	N.D.	0.38 ±0.02^{D}	0.39 ±0.00^{F}	126.62 ±8.45^{D}
7%	5 min	447.32 ±9.98^{X}	N.D.	0.35 ±0.00^{X}	0.41 ±0.01^{X}	65.42 ±4.47^{X}
	10 min	519.24 ±14.59^{Y}	N.D.	0.41 ±0.03^{X}	0.42 ±0.01^{X}	91.84 ±9.20^{X}
	20 min	678.96 ±12.04^{Z}	N.D.	0.36 ±0.02^{X}	0.41 ±0.02^{X}	102.88 ±18.33^{X}

Small letters (a,b,c) show significant difference (α=0.05) at mixing time for 2.5% of egg white for each parameter.
Capital letters (A,B,C) show significant difference (α=0.05) at mixing time for 4% of egg white for each parameter.
Capital letters (D,E,F) show significant difference (α=0.05) at mixing time for 5.5% of egg white for each parameter.
Capital letters (X,Y,Z) show significant difference (α=0.05) at mixing time for 7% of egg white for each parameter.
± Standard deviation

The texture profile analysis of manna bar was followed for different amount of pistachio (15, 25, 35, and 45%) at 120°C for 15 min cooking time and 30 min mixing time. The results are given in Table 4.19. Increasing amount pistachio in manna bar increased hardness, adhesiveness, cohesiveness and chewiness values, but not springiness. Springiness was reduced by increasing pistachio content.

Hardness and chewiness values of the samples increased significantly ($P < 0.05$) by increasing pistachio content. At the highest amount of pistachio containing samples had the highest values of hardness and chewiness values. The results agreed with three samples of "Gaz" prepared with pistachio 18, 28, and 40%, the sample contained 40% of pistachio had the highest value of hardness and chewiness (Hojjati et al. 2015).

Adhesiveness values increased significantly ($P < 0.05$) by increasing amount of pistachio. Speziale et al. (2010) and Hojjati et, al. (2015) found that adhesiveness of some samples, between same brand but different amount of almond, adhesiveness was the highest at high amount of almond. Two studies agreed with the results of the manna bar adhesiveness values of current study. However, Hojjati et al. (2015) reported in another study that in a low amount of almond and pistachio had less adhesiveness values.

The reduction of springiness values in the samples was significant ($P < 0.05$) by increasing the amount of pistachio. Hojjati et al. (2015) found that low amount of pistachio had the highest value of springiness.

The strength of the internal bonds making up the food (Rosenthal, 1999), by increasing amount of pistachio in the samples, cohesiveness values increased significantly ($P < 0.05$) between 15 and 25% amount of pistachio, but it was not significant ($P < 0.05$) between 25, 35 and 45% of pistachio. Hojjati et al. (2015) reported two samples of commercial "Bar D'Agostino" torrone presented higher values of cohesiveness values were more than "Bar Golden" samples. This difference could be due to the higher almond and protein contents of the first company products (40.8 % and 9.3 %, respectively) compared to those of the second one (34.5 % and 6.9 %, respectively), which these results are in line with the results in this study.

The texture profile analysis was found for 10 samples of manna bar without nuts at commercial product, the results are given in Table 4.22. Between the samples the hardness ranges from 230-768g, adhesiveness was -5.21 – -0.01g.s, springiness was 0.38-0.49%, cohesiveness was 0.35- 0.56%, and chewiness was 34-214g.

The texture profile analysis was found for 10 samples of manna bar included pistachio at commercial product, the results are given in Table 4.23. During the analysis, different results were found between the samples, such as hardness between 853-6044g, adhesiveness was -203 – -1.71g.s, springiness was 0.41-0.60%, cohesiveness was 0.29- 0.60%, and chewiness was 136 -1622g.

The importance of textural properties in the current study was effective to make better manna bar. Softness or hardness is closely related to the quality of the texture as the manna bar should be enough suitable to be used. The textural properties of commercial torrone were quite heterogeneous (Lazpita et al., 1991) due to several reasons: Each manufacturer uses different temperature and times during the heating steps, according to their own experience, leading to different final textures. The manual control over operational conditions (temperature and time) also leads to different final textures.

Clearly, hardness and chewiness values are given in the Figures 4.2 and 4.3, these values increased by increasing cooking temperature, cooking time and mixing time. The best quality of texture was obtained at 120°C for 15 min and 30 min mixing time, according to the sensory analysis. Hence, these conditions were used in our further compositional studies.

Table 4.19 Texture profile analysis in manna bar at 120C for 15 min cooking time and 30 min mixing time for different amount of pistachio

Samples	Pistachio (%)	Hardness (g)	Adhesiveness (g.sec)	Springiness (%)	Cohesiveness (%)	Chewiness (g)
P1	15	1051 ±42.87[a]	-82.13 ±4.23[a]	0.57 ±0.01[a]	0.42 ±0.00[a]	256.98 ±1.66[a]
P2	25	2299 ±10.06[b]	-67.90 ±5.56[ab]	0.52 ±0.00[a]	0.47 ±0.00[b]	575.34 ±21.59[b]
P3	35	3816 ±49.73[c]	-49.25 ±12.91[bc]	0.47 ±0.00[b]	0.48 ±0.01[b]	876.47 ±34.11[c]
P4	45	4451 ±83.43[e]	-30.45 ±9.53[c]	0.46 ±0.02[c]	0.50 ±0.02[b]	1051 ±51.52[e]

Small letters (a,b,c,d) show significant difference (α=0.05) at different percentage of pistachio for each parameter.

± Standard deviation

Table 4.20 Texture profile analysis in manna bar without nuts at different brand of company

Samples	Hardness (g)	Adhesiveness (%)	Springiness (%)	Cohesiveness (%)	Chewiness (g)
S1	467.70 ±5.61	-0.26 ±0.09	0.44 ±0.01	0.45 ±0.00	94.67 ±2.76
S2	414.95 ±6.52	-4.72 ±3.51	0.49 ±0.05	0.44 ±0.00	90.40 ±10.40
S3	489.38 ±25.52	-0.64 ±0.56	0.47 ±0.03	0.44 ±0.01	103.82 ±9.74
S4	503.69 ±65.75	-0.88 ±0.08	0.45 ±0.05	0.46 ±0.05	103.38 ±11.24
S5	736.26 ±65.68	-5.21 ±6.20	0.49 ±0.07	0.45 ±0.01	167.26 ±32.89
S6	768.56 ±10.07	-0.01 ±0.08	0.49 ±0.01	0.56 ±0.04	214.82 ±27.46
S7	246.47 ±1.07	-3.47 ±0.47	0.39 ±0.00	0.35 ±0.01	34.15 ±2.78
S8	230.17 ±13.54	-0.30 ±0.05	0.46 ±0.01	0.40 ±0.01	43.19 ±0.30
S9	321.65 ±10.90	-0.29 ±0.40	0.38 ±0.02	0.36 ±0.00	45.62 ±5.52
S10	332.58 ±4.70	-0.28 ±0.23	0.44 ±0.00	0.42 ±0.02	63.65 ±2.60

S: Samples at different brand of company.
± Standard deviation

Table 4.21 Texture profile analysis in manna bar with pistachio at different brand of company

Samples	Hardness (g)	Adhesiveness (g.s)	Springiness (%)	Cohesiveness (%)	Chewiness (g)	Pistachio (%)
PS1	3718.34 ±142.67	-31.61 ±4.65	0.52 ±0.07	0.44 ±0.02	1632.32 ±56.18	37.07 ±0.10
PS2	1104.18 ±21.78	-2.45 ±0.67	0.41 ±0.07	0.29 ±0.07	324.76 ±79.87	29.81 ±1.01
PS3	1335.76 ±111.21	-203.61 ±38.78	0.56 ±0.19	0.60 ±0.09	799.87 ±54.41	24.68 ±8.16
PS4	5151.32 ±609.17	-1.71 ±0.59	0.61 ±0.06	0.50 ±0.00	2605.03 ±387.83	43.58 ±5.13
PS5	853.09 ±109.66	-10.08 ±0.41	0.47 ±0.04	0.38 ±0.01	329.37 ±48.32	17.38 ±2.90
PS6	1390.17 ±85.36	-60.33 ±3.02	0.49 ±0.07	0.36 ±0.02	506.10 ±12.73	35.85 ±9.36
PS7	1357.76 ±128.33	-61.12 ±3.09	0.52 ±0.04	0.35 ±0.02	481.33 ±39.81	26.65 ±4.09
PS8	1059.90 ±122.50	-4.44 ±1.09	0.6 ±0.12	0.51 ±0.07	537.09 ±6.93	23.76 ±13.30
PS9	3045.27 ±21.32	-4.23 ±1.89	0.49 ±0.04	0.46 ±0.04	1400.09 ±8..98	41.26 ±1.92
PS10	6044.81 ±86.09	-20.50 ±1.93	0.56 ±0.08	0.41 ±0.14	2477.80 ±34.02	44.44 ±2.35

S: Samples contain pistachio at different brand of company.

± Standard deviation

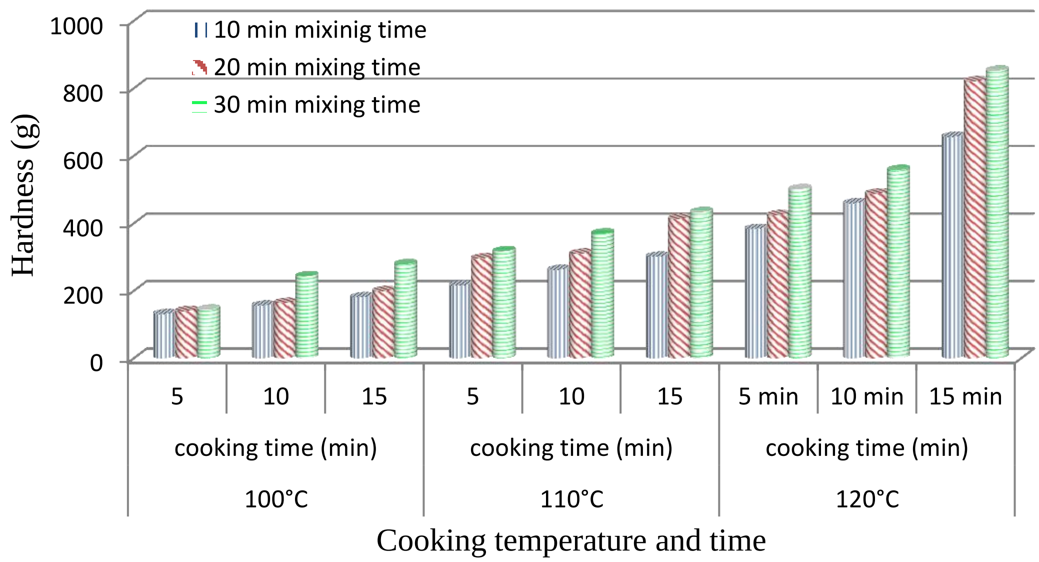

Figure 4.2 Hardness value in manna bar at different temperature, cooking time and mixing time

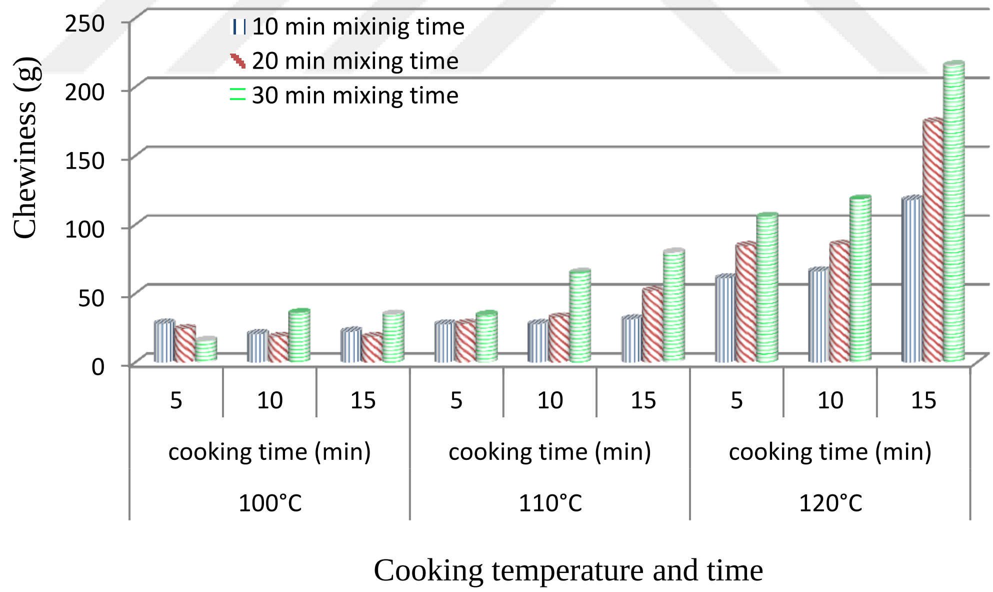

Figure 4.3 Chewiness value in manna bar at different temperature, cooking time and mixing time

4.5 Protein Content

The protein contents of manna bar produced using different processes and recipes, and some commercial of manna bar were measured. Protein content was found at the beginning and end of the process for each recipe. The protein content of manna bar at 100°C for 5 min cooking and 10 min mixing time was found to be 3.05%, and 3.61% at 120°C for 15 min cooking and 30 min mixing time. The protein at the beginning of process was lower than the end of the process in the two samples, which could be due to moisture content.

The protein content of samples was detected at different amount of egg white, while the other materials, temperature and time were kept constant. The samples were produced at 120°C for 15 min cooking time and 20 min mixing time, and different amount of egg white (2.5, 4.0, 5.5, and 7.0%). The protein amount of samples was found to be 1.58, 1.96, 2.52 and 2.95, at 2.5, 4.0, 5.5 and 7.0 of egg white respectively. It was found that adding egg white increased protein content.

The protein content was followed at different amount of pistachios (15, 25, 35, and 45%). The protein content was the highest in a sample having the highest amount of pistachio, which could be due to the high protein content of pistachio. Vázquez-araújo et al. (2006) reported and their results were in an agreement with the result of the study, the protein content increased by increasing the amount of almond. They found that protein content found in Xixona turron (a confectionary) at 54.29, 61.63 and 67.09% of almond were 12.57, 14.45, and 15.96% respectively. The protein content was found in the ranges of 5.78-11.83%, due to the difference amount of pistachio.

Table 4.22 The changes protein, sugar, fat, and ash of manna bar at different amount of pistachio

Sample	Amount of pistachio (%)	Protein (%)	Sugar (%)	Fat (%)	Ash (%)
P1	15.00	6.27	71.50	8.46	1.08
P2	25.00	8.19	64.32	13.82	1.23
P3	35.00	10.16	57.62	19.41	1.32
P4	45.00	12.04	50.89	24.98	1.47

P: samples contain of pistachio.

4.6 Sugar Content

The sugar content of manna bar was followed after producing at different process and recipes, and also in some other commercial manna bars. The sugar content of manna bar was found for the beginning and end samples in the 27 samples of the samples were constant at the recipe but different at temperature and time. The sugar content of manna bar at 100°C for 5 min cooking and 10 min mixing time was found 75.62% and 82.23% at 120°C for 15 min cooking and 30 min mixing time. The sugar content was found to be higher at higher temperature, longer cooking and mixing time, because at high temperature and long cooking with mixing decreased moisture content, hence it increased the proportion of sugar. Vázquez-araújo et al. (2006) reported that at high moisture content sugar content is low in confectionary product.

Four manna bar samples were produced at 120°C for 15 min cooking and 20 min mixing time, and at different amount of egg white (2.5, 4.0, 5.5, and 7.0%), and their sugar contents are given in Table 4.22. The sugar content was found to be 87.42, 85.38, 84.11 and 83.21%, for 2.5, 4.0, 5.5, and 7.0% egg white containing samples respectively. The addition of egg white decreased sugar content, due to increasing of moisture content and protein content, hence the proportion of sugar content decreased.

The sugar content was found for 4 different samples of manna bar prepared with different amount of pistachio (15, 25, 35, and 45%). Their results are given in Table 4.22. P4 prepared at 45% of pistachio had the lowest sugar content whereas, the highest sugar at 15% of pistachio. Increasing the amount of pistachio in the recipe for example in P1 sample (85% of manna bar mixture and 15% pistachio), the sugar was found 71.50%. However in P4 sample, (55% of manna bar mixture and 45% pistachio), the sugar was found 50.89%. Speziale et, al. (2010) reported that the amount of almond decreased sugar content. Vázquez-araújo et al. (2006) found that sugar content of Xixona turron confection at 54.29, 61.63 and 67.09% of almond were 42.60, 38.25, and 33.23%, respectively. The reduction of sugar content by increasing amount of almond was in agreement with the results of this study.

The sugar content of 10 commercial samples of manna bar without nuts was determined. The sugar content was found in the ranges of 58.08-81.32%, due to the difference in recipes. Some factories add flour in to the mixture, therefore the sugar content decreases. When the moisture content is high, the sugar content also decreases. The determination of sugar for 10 commercial samples of manna bar was found between 41.00-60.45%, where the highest amount of pistachio containing sample had the lowest sugar content.

4.7 Fat Content

Fat content of manna bar without nuts at different temperature, cooking time, mixing time, and egg white, recipes and processes are shown in Tables 3.1. and 3.2. The fat content was in the range of 0.10 – 0.25% during these processes and recipes. The fat was low because the materials used for producing manna bar had no fat content. A little amount of fat content come from egg white and flour which was used during the final stage when it was transferred to tray and covered with flour.

The fat content was found for 4 samples of manna bar at 120°C for 15 min cooking and 30 min mixing time, at 15, 25, 35, and 45% of pistachio. Their results are given in Table 4.22. In these samples, the highest fat content was found in the sample containing the highest amount of pistachio. The fat content increased by increasing the pistachio. The fat content was found to be 8.46, 13.93, 19.41, and 24.88% at different amount of pistachio 15, 25, 35, and 45%, respectively. Increase in fat content was due to the high fat content of pistachio. With the same protein content and sugar content, Vázquez-araújo et al.(2006) found that fat contents of Xixona turron confection at 54.29, 61.63 and 67.09% of almond were found to be 31.25, 39.78, and 43.42%, respectively. The fat content of samples increased by increasing almond.

The fat content was found for 10 samples of manna bar produced without nuts in the commercial product. The fat content was found between the ranges of 0.10-0.35%. The highest was 0.35% and more than the result in this study; it could be due to that some factories added flour to the samples; hence the sample took fat from the flour. As well as fat content was found between the ranges 9.23- 23.61% in 10 commercial of manna bar samples and it contained different amount of pistachio. The fat content was the highest at the highest amount of pistachio containing sample.

4.8 Ash Content

The ash content was followed at different temperature, cooking time, mixing time, egg white, and different commercial samples. In general, the ash content of samples was between the ranges of 0.44 -86% for manna bar without nuts.

Manna bar prepared with pistachio had higher ash content than that of the manna bar without nuts. The ash content increased by increasing pistachio, which could be due to the high ash content in pistachio.

The ash content was followed at 120°C for 15 min cooking and 30 min mixing, for different amount of pistachio (15, 25, 35, and 45%). The results were 1.08, 1.23, 1.32, and 1.47% at different amount of pistachio (15, 25, 35, and 45%, respectively.

4.9 Sensory Analysis

In this study, sensory analysis has been conducted for texture and flavor since it had gone under different processes and recipes to produce the best manna bar. Texture and flavor are very important sensory attributes for manna bar because they have great effects on the users to decide the quality. Texture is very important as it needs experts to produce what they want in the final product. Manna bar texture should not be very soft or very hard; this quality attributes makes the texture the focal point. Also, flavor is important for manna bar and its quality for the users, it depends on the amount manna, cardamom and nuts. If the amount of manna, cardamom and nuts are not enough, then the flavor of the final product does not give a good flavor. Cardamom gives a good flavor to manna bar and balance the aroma of egg white.

Sensory analysis conducted for some samples but not all the samples because the textures of some of manna bars were very soft. The reasons behind the softness of the product were low temperature, short cooking and mixing time during the producing. The softness made the product impossible to be tested by panelists. The tests were conducted for samples which have been shown in the Figures 4.4-4.8.

Flavor and texture of manna bar based on the sensory evaluation were followed during producing at processes and recipes. Overall sensory scores were evaluated from Eq. (1) and results are given in Figures 4.7 and 4.8.

Flavor scores increased at 120°C for different mixing time from 5.8 to 7.4 for 10 min cooking time, and from 6.2 to 8.2 for 15 min cooking time (Figure 4.4). Texture score increased for the same temperature and mixing time, from 5.1 to 7.5 for 10 min cooking time, and from 6.65 to 8.6 for 15 min cooking time.

Flavor and texture scores evaluated at 120°C for 15 cooking time at different mixing time and amount of egg white (Figure 4.5). Flavor scores increased from 5.9 to 7, 6.1 to 7.7, 6.2 to 7.4 and 6 to 7.5 for 2.5, 4.0, 5.5 and 7.0% egg white respectively. Texture score decreased from 6.4 to 5.7 and 6.9 to 6.6 for 2.5 and 4.0% egg white respectively (Figure 4.6). This could be due to elasticity and protein gelatinization, which was not convenient to be eaten, by decreasing moisture content and it caused to be so hard. However texture score increased from 6.6 to 6.9 and 6.7 to 7.6 for 5.5 and 7.0% egg white, respectively. The overall sensory scores increased from 5.5 to 8.6 during different processes and recipes. The best sample was produced at 120°C for 15 min cooking time and 30 min mixing time (Figures 4.7).

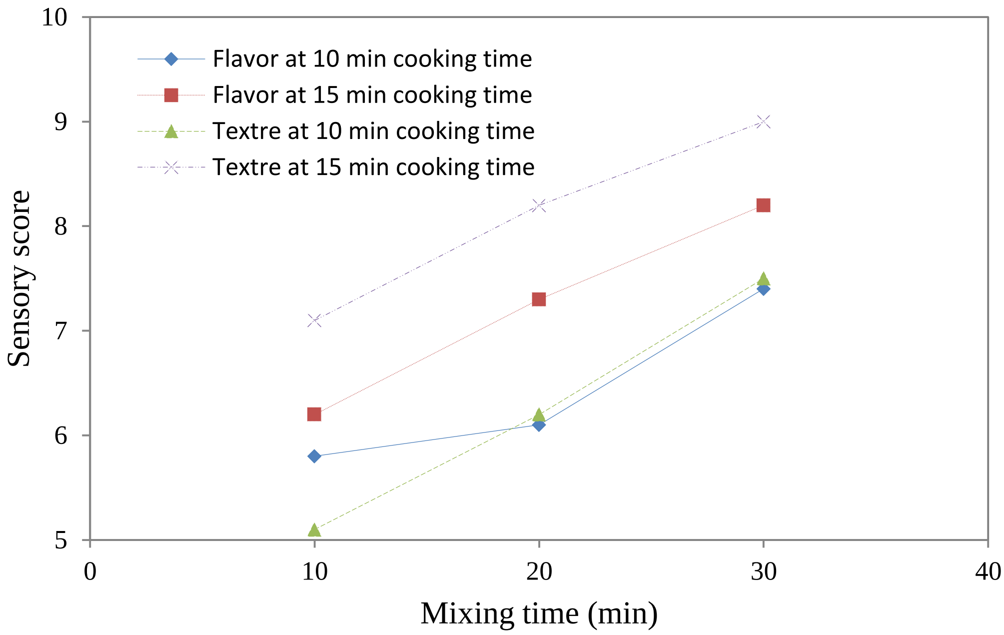

Figure 4.4 Sensory quality attributes of manna bar during mixing time at 10 and 15 min cooking time

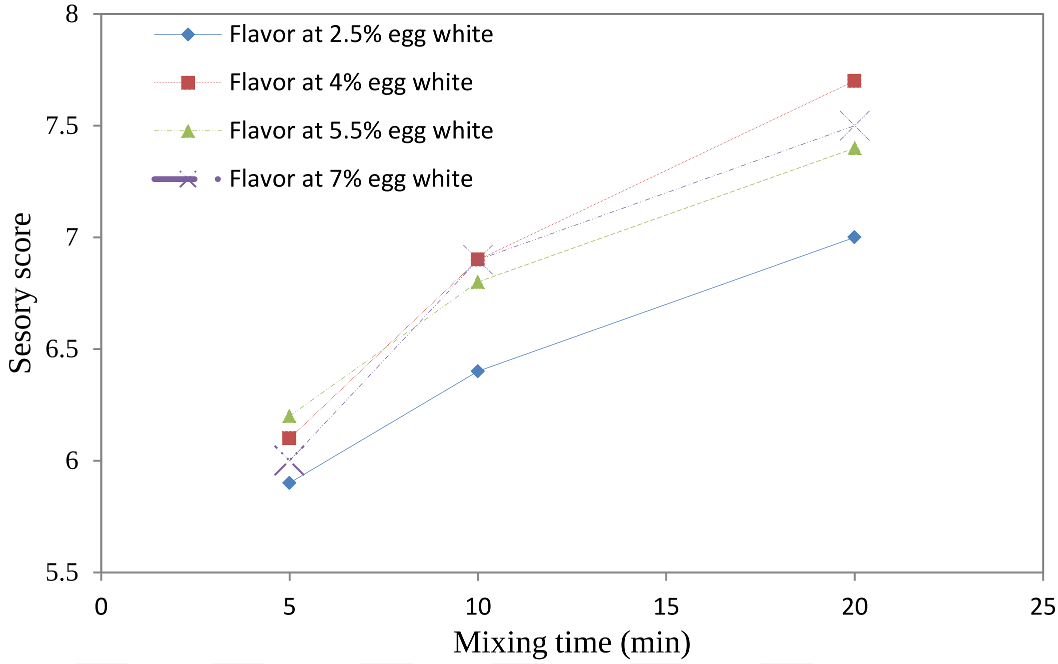

Figure 4.5 Sensory quality of flavor of manna bar during mixing time at different egg white

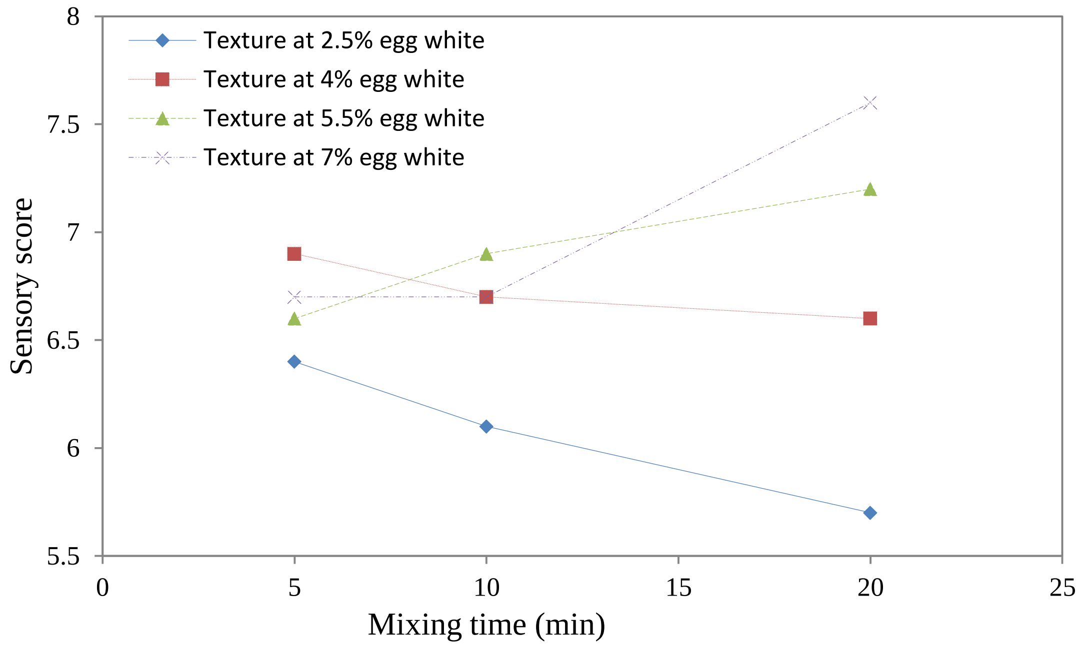

Figure 4.6 Sensory quality of texture of manna bar during mixing time at different egg white

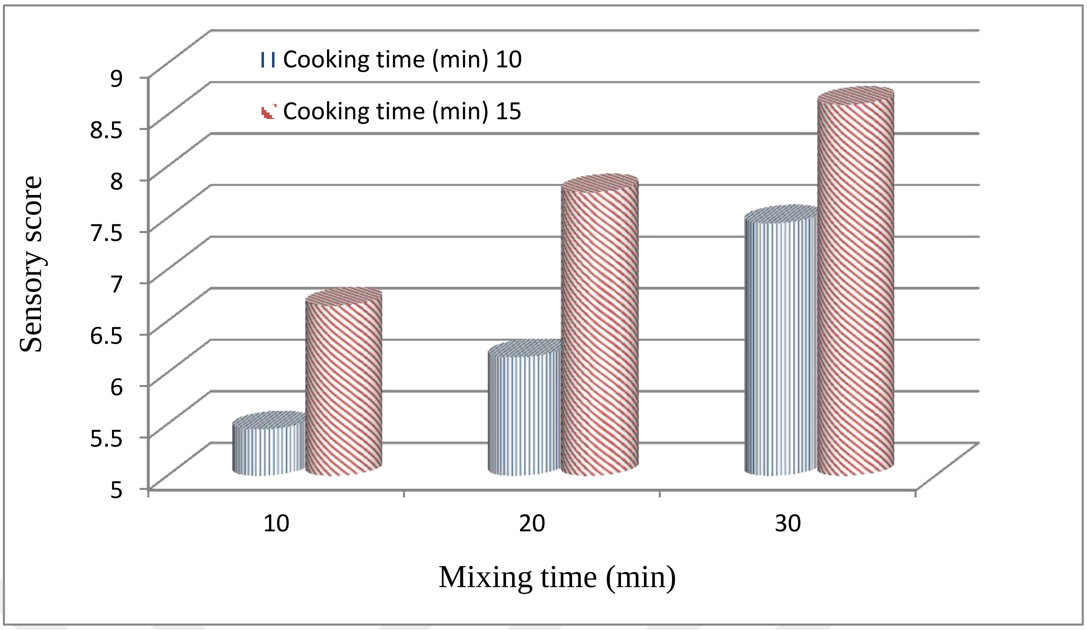

Figure 4.7 Overall sensory quality of manna bar during mixing time at 10 and 15 min cooking time

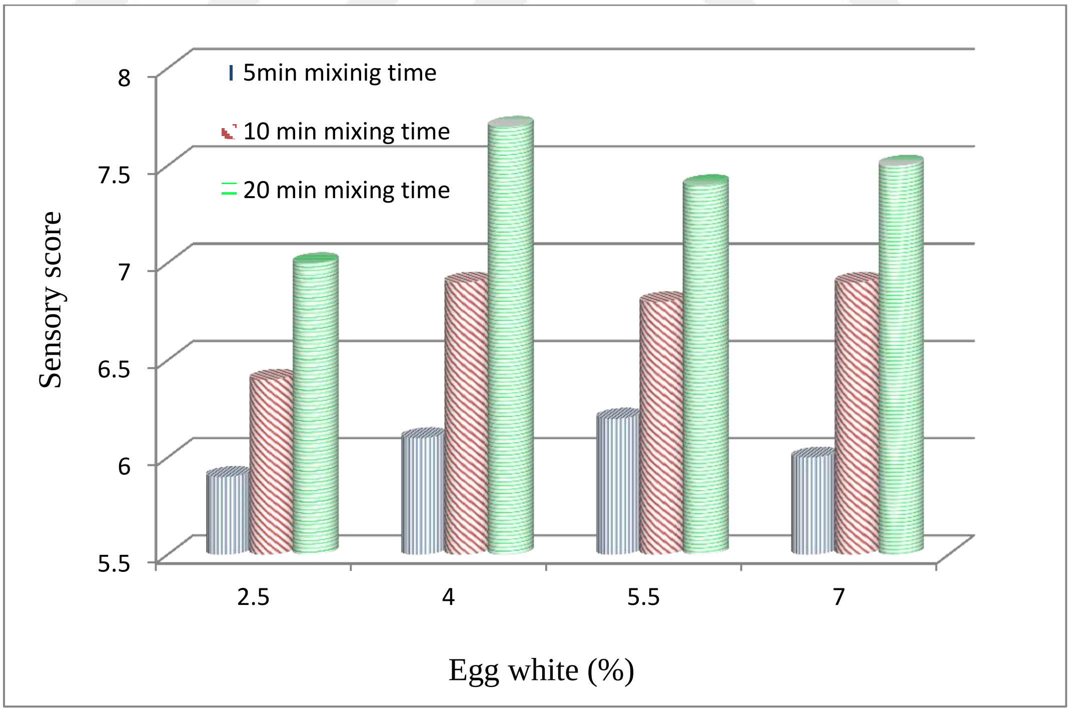

Figure 4.8 Overall sensory quality of flavor and texture of manna bar at 120°C for 15 cooking time at different amount of egg white and mixing time

CHAPTER 5
CONCLUSION

In this study, the effects of different cooking temperature, cooking time, mixing time, pistachio content and amount of egg white on changes in moisture content, pH value, Hunter L^*, a^* and b^* values, BI values, texture attributes, protein content, sugar content, fat content, ash content and sensory analysis of manna bar were investigated during the processing.

The following results were obtained in manna bar production.

Moisture content:

- Cooking temperature, cooking time, mixing time, pistachio and egg white had effects on the moisture content.
- Increasing cooking temperature, cooking time and mixing time decreased moisture content.
- Increase in amount of egg white caused to increase the moisture content.
- Increase of pistachio caused to a decrease the moisture content.
- The best moisture content according to textural attributes obtained as 8.50 and 8.21%. 8.50% moisture content was observed in sample prepared at 120°C for 15 min cooking time and 30 mixing time and of 8.0% of egg white. The sample prepared at 120°C for 15 min cooking time and 20 mixing time and of 7.0% of egg white had 8.21% moisture content.

pH values:

- Increasing mixing time increased pH values.
- Amount of pistachio had no effect on the pH value of the samples.

Hunter Color Values:

- Increasing mixing time and amount of egg white increased lightness value.
- The increase pistachio content decreased lightness value.

- Increasing mixing time decreased in redness value.
- The increased pistachio increased in redness value.

- Increasing mixing time decreased in yellowness value.
- The increased pistachio increased in yellowness value.

- CIE YI decreased by in by increasing mixing time.
- BI values increased by increasing pistachio content.

BI (Browning Index)

- BI values decreased by increasing mixing time.
- BI values increased by increasing pistachio.

Textural Attributes:

- Cooking temperature, cooking time, mixing time and amount of pistachio and egg white had effects on the textural attributes.
- Increasing cooking temperature, cooking time, mixing time and amount of pistachio increased hardness values, but it decreased by increasing egg white.
- Adhesiveness values increased at 100°C by mixing time; however it decreased in most of the samples at 110, 120°C. Adhesiveness values did not determine in samples during the cooking of manna bar at different egg white. Increasing pistachio increased in the adhesiveness values.
- Springiness values increased and decreased at different temperature, cooking and mixing time. Springiness values decreased by increasing pistachio.
- Cohesiveness values increased and decreased at 100°C, but they increased at 110, 120°C for different cooking and mixing time. Cohesiveness values decreased by increasing egg white but increased by increasing pistachio.
- Chewiness values were changeable at 100°C, however they increased at 110, 120°C by increasing cooking and mixing time. The increased amount of egg white caused to decrease chewiness values, but they increased by increasing pistachio.

Protein content:

- The protein content obtained as 3.05% at 100°C for 5 min cooking and 10 min mixing, and 3.61% at 120°C for 15 min cooking and 30 min mixing time.
- The increased amount of egg white and pistachio caused to increase the protein content.

Sugar content:

- The sugar content obtained as 75.62% at 100°C for 5 min cooking and 10 min mixing, and 82.23% at 120°C for 15 min cooking and 30 min mixing time.
- The sugar content decreased by increasing the amount of pistachio and egg white.

Fat content:

- Fat content was below 0.5% in manna bar without nuts, but by increasing the amount of pistachio, the fat content increased.

Ash content:

- Ash content obtained as 0.44 -86% in manna bar without nuts, however ash content increased by increasing the amount of pistachio.

The best condition for producing manna bar was found as:

- Cooking temperature at 120°C for 15 min cooking and 30 min mixing times, with 8% of egg white.
- By increasing egg white, it will be soft; in this case, the mixture needs more heating during the mixing time.
- The sensory attributes improved by increasing amount of pistachio as reducing the sweetness value.

REFERENCES

Anderson, R. A., Broadhurst, C. L., Polansky, M. M., Schmidt, W. F., Khan, A., Flanagan, V. P., & Graves, D. J. (2004). Isolation and characterization of polyphenol type-A polymers from cinnamon with insulin-like biological activity. *Journal of Agricultural and Food Chemistry*, **52**(1), 65-70.

Aquino, L. P., Ferrua, F. Q., Borges, S. V., Cirillo, M. A., & Vieira, A. P. (2009). Influência do pré-tratamento da polpa de pequi (Caryocar brasiliense Camb.) no rendimento do extrato lipídico. *Alimentos e Nutrição Araraquara*, **20**(2), 289-294.

Aranceta, J., Rodrigo, C. P., Naska, A., Vadillo, V. R., & Trichopoulou, A. (2006). Nut consumption in Spain and other countries. *British Journal of Nutrition*, **96**(S2), S3-S11.

Ashby, R., Hjortkjaer, R. K., Stavnsbjerg, M., Gurtler, H., Pedersen, P. B., Bootman, J., & Finn, J. P. (1987). Safety evaluation of Streptomyces murinus glucose isomerase. *Toxicology Letters*, **36**(1), 23-35.

Aynehchi, Y., & Samuelsson, G. (1978). Manna From Astragalus ascendens a rich source of fructose. *Economic Botany*, **32**(3), 295-296.

Azadbakht, M., Pishva, N., & Alinejad, F. (2005). Effect of Manna from Cotoneaster discolor on infant Jaundice (effect on blood bilirubin level). *Journal of Medicinal Plants*, **2**(14), 36-44.

Baby, K. C., & Ranganathan, T. V. (2016). Effect of enzyme pre-treatment on extraction yield and quality of fennel (Foeniculum vulgare) volatile oil. *Biocatalysis and Agricultural Biotechnology*, **8**, 248-256.

Ball, D. W. (2007). The chemical composition of honey. *J. Chem. Educ*, **84**(10), 1643

Bayram, M., & Bozkurt, H. (2007). The use of bulgur as a meat replacement: bulgur-sucuk (a vegetarian dry-fermented sausage). *Journal of the Science of Food and Agriculture*, **87**(3), 411-419.

Bianchi, F., Mangia, A., Mattarozzi, M., & Musci, M. (2011). Characterization of the volatile profile of thistle honey using headspace solid-phase microextraction and gas chromatography–mass spectrometry. *Food Chemistry*, **129**(3), 1030-1036.

Blazquez Abellan, G., Orzaez Villanueva, M. T., & Diaz Marquina, A. (1995). Turrón de Jijona: elaboración artesanal e industrial. *Alimentacion Equipos Y Technologia*, **14**, 47-56.

Bodenheimer, F. S. (1947). The manna of Sinai. *The Biblical Archaeologist*, **10**(1), 2-6.

Borràs, E., Amigo, J. M., van den Berg, F., Boqué, R., & Busto, O. (2014). Fast and robust discrimination of almonds (Prunus amygdalus) with respect to their bitterness by using near infrared and partial least squares-discriminant analysis. *Food Chemistry*, **153**, 15-19.

Bozkurt, H. (2006). Investigation of the effect of sumac extract and BHT addition on the quality of sucuk (Turkish dry-fermented sausage). *Journal of the Science of Food and Agriculture*, **86**(5), 849-856.

Bozkurt, H., & Erkmen, O. (2004). Effect of nitrate/nitrite on the quality of sausage (sucuk) during ripening and storage. *Journal of the Science of Food and Agriculture*, **84**(3), 279-286.

Campbell, G. M., & Mougeot, E. (1999). Creation and characterisation of aerated food products. *Trends in Food Science & Technology*, **10**(9), 283-296.

Chempakam, B., & Sindhu, S. (2008). 3 Small Cardamom. Chemistry of Spices, 41.

Chiralt, A., Galotto, M. J., & Fito, P. (1991). Changes in rheological properties and particle-size distribution during the manufacture of ‘Xixona turrón’. *Journal of Food Engineering*, **14**(2), 117-128.

Crane, E. (1990). Bees and beekeeping: science, practice and world resources. Heinemann Newnes.

Crews, C., Hough, P., Godward, J., Brereton, P., Lees, M., Guiet, S., & Winkelmann, W. (2005). Study of the main constituents of some authentic hazelnut oils. *Journal of Agricultural and Food Chemistry*, **53**(12), 4843-4852.

Davis, J. P., Foegeding, E. A., & Hansen, F. K. (2004). Electrostatic effects on the yield stress of whey protein isolate foams. *Colloids and Surfaces B: Biointerfaces*, **34(**1), 13-23.

de Oliveira Sousa, A. G., Fernandes, D. C., Alves, A. M., De Freitas, J. B., & Naves, M. M. V. (2011). Nutritional quality and protein value of exotic almonds and nut from the Brazilian Savanna compared to peanut. *Food Research International*, **44**(7), 2319-2325.

Dignum, M. J., Kerler, J., & Verpoorte, R. (2002). Vanilla curing under laboratory conditions. *Food Chemistry*, **79**(2), 165-171.

Dziedzic, S. Z., & Kearsley, M. W. (1995). The technology of starch production. In *Handbook of Starch Hydrolysis Products and Their Derivatives* . Springer US (pp. 1-25).

Dziki, D., Gawlik-Dziki, U., Różyło, R., & Miś, A. (2015). Drying and grinding characteristics of four-day-germinated and crushed wheat: A novel approach for producing sprouted flour. *Cereal Chemistry*, **92**(3), 312-319.

Elshafie, M. M., Nawar, I. A., Algamal, M. A., & Ahmad, S. M. (2012). Evaluation of the biological effects for adding cinnamon volatile oil and TBHQ as antioxidant on rats' lipid profiles. *Asian Journal of Plant Sciences*. **11**(3), 100.

Erkan, M. E., Vural, A., Baran, M. S., Güran, H. S., & Durmusoglu, H. (2014). Physico-chemical and microbiological properties of manna (gezo) samples collected from retailers in south-east of Turkey. *Research on Crops*, **15**(4), p902-906. 5p.

Frederick, E. (1819). Remarks on the substance called gez or manna, found in Persia and Armenia. *Transaction of Literary Society of Bombay*, **1**, 251-258.

Ghassemi Dehkordi, N., Sajjadi, S. E., Ghannadi, A., Amanzadeh, Y., Azadbakht, M., & Asghari, G. R. (2003). Iranian herbal pharmacopoeia (IHP). *Hakim R J*, **63**-9.

Glinsmann, W. H., Irausquin, H., & Park, Y. K. (1986). Evaluation of health aspects of sugars contained in carbohydrate sweeteners. Report of Sugars Task Force, 1986. *The Journal of Nutrition*, **116**(11), S1-216.

Golob, T., & Plestenjak, A. (1999). Quality of Slovene honey. *Food technology and Biotechnology*, **37**, 195-202.

Grami, B. (1998). Gaz of Khunsar: the manna of Persia. *Economic Botany*, **52**(2), 183-191.

Harrison, S. G. (1950). Manna and its sources. *Kew Bulletin*, **5**(3), 407-417.

Hartel, R. W., Ergun, R., & Vogel, S. (2011). Phase/state transitions of confectionery sweeteners: thermodynamic and kinetic aspects. *Comprehensive Reviews in Food Science and Food Safety*, **10**(1), 17-32.

Hojjati, M., Speziale, M., Noguera-Artiaga, L., & Carbonell-Barrachina, Á. A. (2015). Volatile Composition, Texture and Sensory Description of Gaz (Traditional Persian Confection). *Journal of Texture Studies*, **46**(6), 440-454.

Hojjati, M., Speziale, M., Vázquez-Araújo, L., Mincione, A., & Carbonell-Barrachina, A. A. (2015). Instrumental texture properties of Spanish Turrón, Italian Torrone and French Nougat. *Journal of Food and Bioprocess Engineering*, **1**(2), 21-29.

Jackson, E. B. (1995). Liquorice paste cream paste and aerated confectionery. In *Sugar Confectionery Manufacture* (pp. 218-235). Black Academic and Professional London.

Jayaprakasha, G. K., Negi, P. S., Jena, B. S., & Rao, L. J. M. (2007). Antioxidant and antimutagenic activities of Cinnamomum zeylanicum fruit extracts. *Journal of Food Composition and Analysis*, **20**(3), 330-336.

Jumbo, L. O. V., Faroni, L. R., Oliveira, E. E., Pimentel, M. A., & Silva, G. N. (2014). Potential use of clove and cinnamon essential oils to control the bean weevil, Acanthoscelides obtectus Say, in small storage units. *Industrial Crops and Products*, **56** (3) 27-34.

Jun-xia, X., Hai-yan, Y., & Jian, Y. (2011). Microencapsulation of sweet orange oil by complex coacervation with soybean protein isolate/gum Arabic. *Food Chemistry*, **125**(4), 1267-1272.

Kaškonienė, V., Venskutonis, P. R., & Čeksterytė, V. (2008). Composition of volatile compounds of honey of various floral origin and beebread collected in Lithuania. *Food Chemistry*, **111**(4), 988-997.

Korikanthimath, V. S., Rao, G., & Hiremath, G. M. (2002). Cultivation of cardamom (Elettaria cardamomum) in valley bottoms under evergreen forest shade.

Lanza, A. T. (2005). Sicilian Manna: A Sweet Gift of Nature. *Gastronomica*, **5**(1), 38-40.

Lavine, B. K., Corona, D. T., & Perera, U. D. N. T. (2012). Analysis of vanilla extract by reversed phase liquid chromatography using water rich mobile phases. *Microchemical Journal*, **103**, 49-61.

Leibowitz, J. (1944). Isolation of trehalose from desert manna. *Biochemical Journal*, **38**(3), 205.

Lluch, M. A., Galotto, M. J., & Chiralt, A. (1992). Scanning Electron Microscopy Studies of a Typical Spanish Confectionery Product:" Xixona Turron". *Food Structure*, **11**(2), 10.

Loghavi, M., Souri, S., & Khorsandi, F. (2011). Physical and Mechanical Properties of Almond (Prunus dulcis l. cv. 7Shahrood). In *2011 Louisville, Kentucky, August 7-10, 2011* (p. 1). American Society of Agricultural and Biological Engineers.

Luck, P. J., Bray, N., & Foegeding, E. A. (2002). Factors determining yield stress and overrun of whey protein foams. *Journal of Food Science*, **67**(5), 1677-1681.

Lv, J., Huang, H., Yu, L., Whent, M., Niu, Y., Shi, H., & Yu, L. L. (2012). Phenolic composition and nutraceutical properties of organic and conventional cinnamon and peppermint. *Food Chemistry*, **132**(3), 1442-1450.

Madene, A., Jacquot, M., Scher, J., & Desobry, S. (2006). Flavour encapsulation and controlled release–a review. *International Journal of Food Science & technology*, **41**(1), 1-21.

Mageean, M. P., Kristott, J. U., & Jones, S. A. (1991). *Physical properties of sugars and their solutions*. *British Food Manufacturing Industries Research Association*.

Martínez, M. L., Labuckas, D. O., Lamarque, A. L., & Maestri, D. M. (2010). Walnut (Juglans regia L.): genetic resources, chemistry, by-products. *Journal of the Science of Food and Agriculture*, **90**(12), 1959-1967.

Martínez, M. L., Mattea, M. A., & Maestri, D. M. (2008). Pressing and supercritical carbon dioxide extraction of walnut oil. *Journal of food engineering*, **88**(3), 399-404.

Maruenda, H., del Lujan Vico, M., Householder, J. E., Janovec, J. P., Cañari, C., Naka, A., & Gonzalez, A. E. (2013). Exploration of Vanilla pompona from the Peruvian Amazon as a potential source of vanilla essence: quantification of phenolics by HPLC-DAD. *Food Chemistry*, **138**(1), 161-167.

Maskan, M., & Karataş, Ş. (1998). Fatty acid oxidation of pistachio nuts stored under various atmospheric conditions and different temperatures. *Journal of the Science of Food and Agriculture*, **77**(3), 334-340.

Mehra, K. (2001). Indian system of innovation in biotechnology—a case study of cardamom. *Technovation*, **21**(1), 15-23.

Molania, T., Moghadamnia, A. A., Pouramir, M., Aghel, S., Moslemi, D., Ghassemi, L., & Motallebnejad, M. (2012). The effect of Cinnamaldehyde on mucositis and salivary antioxidant capacity in gamma-irradiated rats (a preliminary study). *DARU Journal of Pharmaceutical Sciences*, **20**(1), 89.

Neill, G., Ala'a, H., & Magee, T. R. A. (2012). Optimisation of time/temperature treatment, for heat treated soft wheat flour. *Journal of Food Engineering*, **113**(3), 422-426.

Nicknejad, A. 1976. [The Mannas of Iran.] Doctoral Dissertation, *College of Pharmacy*, *University of Tehran*. (in Persian).

Nwalo, N. F., & Cynthia, A. O. (2014). Glucose syrup production from cassava peels and cassava pulp. *Int. J. Curr. Microbiol. App. Sci*, **3**(12), 781-787.

Nys, Y., Bain, M., & Van Immerseel, F. (Eds.). (2011). *Improving the Safety and Quality of Eggs and Egg Products: Egg Chemistry, Production and Consumption*(Vol. 1). Elsevier.

Olaitan, P. B., Adeleke, O. E., & Iyabo, O. O. (2007). Honey: a reservoir for microorganisms and an inhibitory agent for microbes. *African Health Sciences*, **7**(3).

Overton, S. V., & Manura, J. J. (1994). Flavor and aroma in commercial bee honey: a purge-and-trap thermal desorption technique for the identification and quantification of volatiles and se mivolatiles in honey. *American Laboratory*, **26**(6), 45-45.

Pancoast, H. M., & Junk, W. (1980). *Handbook of sugars*. AVI Pub. Co..

Pernell, C. W., Foegeding, E. A., Luck, P. J., & Davis, J. P. (2002). Properties of whey and egg white protein foams. *Colloids and Surfaces A: Physicochemical and Engineering Aspects*, ***204***(1), 9-21.

Peter, P. N., & Bell, R. W. (1930). Normal and modified foaming properties of whey-protein and egg-albumin solutions. *Industrial & Engineering Chemistry*, **22**(10), 1124-1128.

Peterson, D. W., George, R. C., Scaramozzino, F., LaPointe, N. E., Anderson, R. A., Graves, D. J., & Lew, J. (2009). Cinnamon extract inhibits tau aggregation associated with Alzheimer's disease in vitro. *Journal of Alzheimer's Disease*, **17**(3), 585-597.

Przygodzka, M., Zielińska, D., Ciesarová, Z., Kukurová, K., & Zieliński, H. (2014). Comparison of methods for evaluation of the antioxidant capacity and phenolic compounds in common spices. *LWT-Food Science and Technology*, **58**(2), 321-326.

Ramezany, F., Kiyani, N., & Khademizadeh, M. (2013). Persian manna in the past and the present: an overview. *American Journal of Pharmacological Sciences*, **1**(3), 35-37.

Ravai, M. (1992). Quality characteristics of California walnuts. *Cereal foods world (USA)*. 37(5) 362- 366.

Rebello, C. J., Greenway, F. L., & Finley, J. W. (2014). Whole grains and pulses: a comparison of the nutritional and health benefits. *Journal of Agricultural and Food Chemistry*, **62**(29), 7029-7049.

Rosengarten Jr, F. (2004). *The book of edible nuts*. Courier Corporation.

Sabry, Z. I., & Atallah, N. A. (1961). Identification of sugars in the manna of Northern Iraq. *Nature*, **190**(4779), 915-916.

Santiago-Adame, R., Medina-Torres, L., Gallegos-Infante, J. A., Calderas, F., González-Laredo, R. F., Rocha-Guzmán, N. E., . & Bernad-Bernad, M. J. (2015). Spray drying-microencapsulation of cinnamon infusions (Cinnamomum zeylanicum) with maltodextrin. *LWT-Food Science and Technology*, **64**(2), 571-577.

Schenck, F. W. (2007). Glucose and Glucose-Containing Syrups. *Ullmann's Encyclopedia of Industrial Chemistry*.

Schmidt, L. D., Blank, G., Boros, D., & Slominski, B. A. (2007). The nutritive value of egg by-products and their potential bactericidal activity: in vitro and in vivo studies. *Journal of the Science of Food and Agriculture*, **87**(3), 378-387.

Serra Bonvehí, J., & Ventura Coll, F. (2003). Flavour index and aroma profiles of fresh and processed honeys. *Journal of the Science of Food and Agriculture*, **83**(4), 275-282.

SHOKRAII, E. H. (1977). Chemical composition of the pistachio nuts (Pistacia vera L.) of Kerman, Iran. *Journal of Food Science*, **42**(1), 244-245.

Speziale, M., Vázquez-Araújo, L., Mincione, A., & Carbonell-Barrachina, Á. A. (2010). Volatile composition and sensory analysis of Italian gianduja torrone. *Journal of the Science of Food and Agriculture*, **90**(10), 1605-1613.

Stephens, J. M., Greenwood, D., Fearnley, L., Bong, J., Schlothauer, R. C., & Loomes, K. (2015). Honey production and compositional parameters. *Processing and Impact on Active Components in Food.*

Sun, Y., Hayakawa, S., Ogawa, M., Fukada, K., & Izumori, K. (2008). Influence of a rare sugar, D-psicose, on the physicochemical and functional properties of an aerated food system containing egg albumen. *Journal of Agricultural and Food Chemistry*, **56**(12), 4789-4796.

Sze-Tao, K. W. C., & Sathe, S. K. (2000). Walnuts (Juglans regia L): proximate composition, protein solubility, protein amino acid composition and protein in vitro digestibility. *Journal of the Science of Food and Agriculture*, **80**(9), 1393-1401.

Takavar, S., & Mohamadi, M. (2008). Producer, s Factors and Mechanisms of Manna in Iran. *Journal of Medicinal Plants*, **4**(28), 28-37.

Tavakolipour, H. (2015). Postharvest operations of pistachio nuts. *Journal of Food Science and Technology*, **52**(2), 1124-1130.

Taverna F. 2009. *Personal communication*. Taverna Francesco s.n.c. Di Francesco Taverna & C. – Taurianova (RC), Italy

Torres, L. R. O., Shinagawa, F. B., Santana, F. C., Araújo, E. S., Oropeza, M. V. C., Macedo, L. F. L., & Mancini-Filho, J. (2016). Physicochemical and antioxidant properties of the pequi (Caryocar brasiliense Camb.) almond oil obtained by handmade and cold-pressed processes. *International Food Research Journa*l, **23**(4): 1541-1551

Troccoli, A., Borrelli, G. M., De Vita, P., Fares, C., & Di Fonzo, N. (2000). Mini review: durum wheat quality: a multidisciplinary concept. *Journal of Cereal Science*, **32**(2), 99-113.

Vallverdú-Queralt, A., Regueiro, J., Martínez-Huélamo, M., Alvarenga, J. F. R., Leal, L. N., & Lamuela-Raventos, R. M. (2014). A comprehensive study on the phenolic profile of widely used culinary herbs and spices: rosemary, thyme, oregano, cinnamon, cumin and bay. *Food Chemistry*, **154**, 299-307.

Vázquez, L., Verdú, A., Miquel, A., Burló, F., & Carbonell-Barrachina, A. A. (2007). Changes in physico-chemical properties, hydroxymethylfurfural and volatile compounds during concentration of honey and sugars in Alicante and Jijona turrón. *European Food Research and Technology*, **225**(5-6), 757-767.

Vázquez-Araújo, L., Verdú, A., Murcia, R., Burló, F., & CARBONELL-BARRACHINA, A. A. (2006). Instrumental texture of a typical Spanish confectionery product Xixona turron as affected by commercial category and manufacturing company. *Journal of Texture Studies*, **37**(1), 63-79.

Venkitasamy, C., Brandl, M. T., Wang, B., McHugh, T. H., Zhang, R., & Pan, Z. (2017). Drying and decontamination of raw pistachios with sequential infrared drying, tempering and hot air drying. *International Journal of Food Microbiology*, **246**, 85-91.

Verdú, A., Vázquez-Araujo, L., & Carbonell-Barrachina, Á. A. (2007). Mathematical quantification of almond content in Jijona turrón. *European Food Research and Technology*, **226**(1-2), 301-306.

White Jr, J. W. (1975). Physical characteristics of honey. *Honey: A Comprehensive Survey. E. Crane, ed*.

Woodruff, J. G. (1979). *Tree nuts: production, processing, products* (No. Ed. 2). AVI Publishing Co. Inc.

Yazdanparats, S., Ziarati, P., & Asgarpanah, J. (2014). Nutritive values of some Iranian Manna. *Biosci Biotechnol Res Asia*, **11**, 1025-1029.

Yu, L., Haley, S., Perret, J., & Harris, M. (2002). Antioxidant properties of hard winter wheat extracts. *Food Chemistry*, **78**(4), 457-461.

Zhou, M., Robards, K., Glennie-Holmes, M., & Helliwell, S. (1999). Analysis of volatile compounds and their contribution to flavor in cereals. *Journal of Agricultural and Food Chemistry*, 47(10), 3941-3953.

Žilić, S., Basić, Z., Hadži-Tašković Šukalović, V., Maksimović, V., Janković, M., & Filipović, M. (2014). Can the sprouting process applied to wheat improve the contents of vitamins and phenolic compounds and antioxidant capacity of the flour. *International Journal of Food Science & Technology*, **49**(4), 1040-1047.

(https://www.bookdepository.com/Glucose-Syrups-Peter-Hull/9781405175562)