The Role of Honey in Improving Rheological Properties of Nut Butters, Spreads, and Pastes: A Review Study

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Abstract

Honey, as a nutraceutical and a functional substance, plays the role of a sweetener and has an impact on rheological characteristics, including flow properties and viscosity. This study aims to critically review the importance of honey and its uses in terms of rheological properties in nut butters, spreads, and pastes. A total of 49 reviews published in major food and science journals were assessed in this review article to study their methods. Assessments were made based on some explicit criteria of information synthesis. Research indicates the useful role of honey in the food industry, especially in nut butters, spreads, and pastes through imparting desired texture and rheological properties. Nuts and their related products have received much attention in developing a healthy lifestyle. Accordingly, they are commonly used, apart from in a natural form, as ingredients in various processed foods, such as confectionery and bakery products as pastes and spreads. Rheological properties can improve processing and end-use quality. Understanding rheology of foodstuffs is effective in predicting long-term stability of products, especially that of plant-based oils.

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Introduction

Health concerns are increasing over consumption of dairy butter because of its high fat content that necessitates the finding of alternative plant-based butters, like nut butters and seed butters [1, 2]. In addition, recent changes in dietary habits have attracted the attention of food technologists and the manufacturing industry. With the advent of the modern life, health-related issues have turned into an important issue that should be dealt with. Obesity and other modern diseases are turning into a significant health problem that partly results from increased energy intake and partly from reduced energy expenditure [3]. Thus, upon making great efforts, various strategies have been developed to meet customer needs for fighting such problems.

Macronutrients, such as proteins, carbohydrates, and lipids (fats), form the major part of the human diet necessary for maintaining a healthy lifestyle. The food industry has always attempted to supply these vital elements as constituents of various foodstuffs [4]. According to nutritionists, a balanced amount of lipids should be included in the daily diet because of their chemical, nutritional, and physical properties. The amount of oil extracted from nuts varies, which is 44% in pistachio, 49% in peanuts, 65% in walnuts [5].

The term 'nut butter' defines a product with approximately 90% of nut ingredients, while the term 'nut spread' refers to a spreadable product with at least 40% of nut ingredients [5-7]. Nut spreads and nut butters are widely used as a major item of diets. Nuts are rich in proteins, carbohydrates, and oils, which provide useful nutrients. Continuous efforts have been made to improve overall acceptance of nut butters as well as their flavor, composition, and organoleptic features. Nut butters or spreads are usually produced by grinding nuts in the presence of an edible oil to form a nut paste. Honey is added to the nut paste as a flavoring factor. In addition, other ingredients could be added to impart various desired textures to nut butters and spreads. Consumption of nuts, as whole nuts, could be difficult for certain age groups, such as children and old people, due to their hard shell. Besides, processing and handling them could negatively affect their quality. Factors, such as the raw kernel quality, roasting temperature, and time affect the quality of the resulting nut paste, which in turn directly determines the overall quality of the nut butter.

Honey

Honey is a natural product with unique types of phenolic and flavonoid compounds, which is produced by honey bees and later modified and stored by them as a viscous

liquid. It has been consumed for many centuries, yet little is known about this wonderful product of the nature [8]. In addition to its traditional use as a natural sweetener, honey has many biological and clinical benefits compared to other natural products; thus, it has various clinical applications [9]. On average, honey consists of around 200 specific chemical constituents [10]. Every constituent has a distinct nutritional attribute, and all constituents play a synergistic role in turning honey into a source of a variety of applications [11]. Several studies have reported anti-inflammatory, antioxidant, antibacterial, and anti-diabetic properties for honey [12-14]. Like other natural products, it is confirmed that honey can be applied as a cardioprotective agent [15]. In a particular case, for instance, structural characteristics of honey as part of a smooth delivery system in combination with gelatin were studied in providing the functional matrix. Accordingly, up to 75% (w/w) honey was added to improve molecular dynamics of the gelatin-honey system. Promising results of this study could be used for future applications in treating ailments orally and topically [16]. The amount of vitamins and minerals contributing to the recommended daily intake (RDI) for honey is shown in Table 1. Temperature, moisture, and composition play a leading role in determining rheology of honey. In addition, raising the temperature lowers its viscosity. The water content of honey is related to the loss modulus and the steady shear viscosity of 20-60. The viscous modulus of honey could increase upon an increase in the angular frequency. In general, honey is considered a relatively viscous Newtonian fluid. Herschel-Bulkley and Power Law models have been widely used to describe the flow behavior of non-Newtonian kinds of honey.

Honey imparts various rheological attributes to plant-based products, which meet needs of food experts in producing a desirable foodstuff. In this study, the power law was used to exhibit the rheological behavior of honey. Honey has a pseudoplastic fluid behavior. The Arrhenius model can properly model effects of temperature on viscosity of honey. Table 2 shows calculation results for determining rheological characteristics of honey [17]. As the table shows, the higher the shear rate is, the lower the viscosity of honey will be, which indicates the pseudoplastic behavior of the tested honey. Accordingly, many studies have reported that honey has a pseudoplastic behavior [18].

Incomplete understanding of the antibacterial activity of honey is a barrier to its clinical applicability due to the interaction among various compounds as well as their various concentrations among different types of honey. However, this unique property has increased the interest in further medical use of it [15]. Many

studies have tried to explore various physiochemical and fundamental properties of honey [6]. Although honey has a low water activity (aw* 0.6) and is shelf-stable, it is prone to microbial contamination by preharvest and postharvest sources.

Table 1- Nutrients in honey as human requirements [17]

Nutrient	Unit	Average amount in 100 g of honey	Recommended daily intake
Energy equivalent	Kcal	304	**2800**
Vitamins			
B1 (Thiamin)	Mg	0.004 - 0.006	**1.5**
B2 (Riboflavin)	Mg	0.002- 0.06	**1.7**
Nicotinic acid (niacin)	Mg	0.11- 0.36	**20**
B6 (Pyridoxine)	Mg	0.008 - 0.32	**2**
Pantothenic acid	Mg	0.02 - 0.11	**10**
C (Ascorbic acid)	µg	2.2-2.4	**60**
Minerals			
Calcium	Mg	4-30	**1000**
Chlorine	mg	2-20	
Copper	mg	0.01-0.1	**2**
Iron	mg	1-3.4	**18**
Magnesium	mg	0.7-13	**400**
Phosphorous	mg	2-60	**1000**
Potassium	mg	10-470	**-**
Sodium	mg	0.6-40	**-**
Zinc	**mg**	**0.2-0.5**	**15**

Table 2- Results of Research on Rheological Properties of a Type of Australian Honey [18]

RPM	RPS	$\dot{\gamma}$	μ (mPas)	ln $\dot{\gamma}$	n-1	ln K	n	K	R^2
60	1	0.42	6540	-0.84					
60	1	0.42	6620	-0.84					
50	0.83	0.35	6610	-1.03					
50	0.83	0.35	6750	-1.03					
30	0.5	0.21	6890	-1.54	0.05	8.75	0.947	6312.2	**0.83**
30	0.5	0.21	6980	-1.54					
20	0.33	0.14	6910	-1.94					
20	**0.33**	**0.14**	**7010**	**-1.94**					

Honey is slightly acidic (pH=3.9), which makes it a suitable culture for specific yeasts and spore-forming bacteria. According to research, honey caused over 1,000 cases of infant botulism annually [19]. Thus, it should not be given to infants under 12 months of age. Sources and varieties of the microbial flora found in honey have been reviewed comprehensively. Certain severe diseases associated with honey have been a reason for the public being warned against addition of honey to diets of infants under 1 year of age. Sweeteners could be used to add value to other products via some novel strategies, such as enzymatic treatment [20]. Despite extensive use of sweeteners in a variety of foods, their use is gradually decreasing because of remarkable benefits of other replacers, such as honey and the public's tendency to consume more value-added foodstuffs. The effects of adding other sweeteners have been investigated in the food industry; for example, date syrup (as a sugar replacement) improves physicochemical, rheological, and sensory properties of dairy products to a great extent [21, 22].

Honey has been widely used to reformulate either partially or fully sugar replacements in most parts of food categories, including bakery products, chocolates, ice creams, desserts, jams, jellies, and especially nut spreads and butters. When mixing two sweeteners, sweetness intensity of the blend may change significantly (cumulative), which could be either higher (synergized) or lower (suppressed) than when using only one sweetener [23].

Pine honey is an unusual type of honey produced from honeydew secreted by the insect Marchalina hellenica [24, 25]. It is produced only in Greece and Turkey and is considered honey of a high quality, which has no sharp taste or aroma, with a very low tendency to be crystallized [27]. Among the mineral contents existing in pine honey, potassium is found to be an element of the largest quantity with an average content of 3,802 ppm, which accounts for only less than 50% of the minerals [26]. Pine honey has been used with sesame paste (tahini) as a blend to examine various factors present in this product. Accordingly, sensory, rheological, and physical attributes of the blend of pine honey and tahini could be used to improve its design and processing on an industrial scale [27].

Nutritional properties of nuts

Table 3 shows chemical compositions of pistachios and some nuts. In dried pistachios, the moisture content is 5%. Low moisture contents are very important in storage and processing. The oil content is high in most nuts (over 50%).

Table 3- Compositions of some nuts (100gr) [29, 31]

Composition	Pistachios	Almonds	Hazelnuts	Walnuts
Water (%)	5.3	4.7	5.8	3.5
Proteins (gr)	19.3	18.6	12.6	14.8
Total oil (gr)	53.7	54.2	62.4	64
Carbohydrates (gr)	19	19.5	16.7	15.8
Fiber (gr)	1.9	2.6	3	2.1
Ash (gr)	2.7	3	2.5	1.9
Ca (mg)	131	234	209	99
P (mg)	500	504	337	380
Fe (mg)	7.3	4.7	3.4	3.1
Na (mg)	7	5	3	3
P (mg)	972	773	704	450
Mg (mg)	158	270	184	131
Zn (mg)	2.3	3.6	2.2	2.5
Mn (mg)	1.20	2.53	6.16	3.41
Vitamin B6 (mg)	1.7	0.13	0.56	0.5
Thiamin (mg)	0.67	0.24	0.46	0.33
Riboflavin (mg)	0.3	1.1	0.1	0.2
Niacin (mg)	1.4	3.5	0.9	0.9
Vitamin A (µg retinol)	22	2	3	4
Vitamin C (mg)	30	Trace	Trace	2
Vitamin K (mg)	13.2	-	14.2	2.4
Vitamin E (mg)	4.6	26.2	15.2	2.9
Folate (µg)	67	49	72	66
Arginine (mg)	2.47	2.13	2.21	2.28
Phytosterols (mg)	214	120	96	72
Energy (Cal)	**594**	**598**	**634**	**651**

High oil amounts have an important role in the curing, storage, and processing of nuts [28]. The protein content of nuts varies in the range of 5- 30%. The protein content of pistachios, walnuts, and almonds is 20%. Natural carbohydrates are 20% in pistachios and almonds, as well as 15% in walnuts and hazelnuts. In addition, whole carbohydrates are low in nuts, but they create a sweet taste in some nuts, such as pistachios. Besides, the starch content is very low in nuts. Most nuts are rich in phosphorous, potassium, and magnesium; however, they contain a small amount of iron, sodium, and calcium. The amount of vitamins is low in most nuts. Pistachios have a moderate amount of vitamin A, yet other nuts have a low content of vitamin A. Hazelnuts, walnuts, and almonds are rich sources of vitamin B_1. The riboflavin content of almonds is 1%, but it is low in other nuts, such as pistachios. The niacin content of pistachios is less than 2%. Except pistachios with the ascorbic acid content of 30%, other nuts have a low content of ascorbic acid [29, 30].

Nut spreads and nut butters

The major goal of combining nuts and seeds in today's regular diets is to obtain a suitable form of butter. Seeds and nuts are commonly prepared by roasting, grinding, and refrigerating them to be consumed fresh. During these processes, it is important to retain nutritional properties of nuts and seeds to maintain benefits of these fresh products in the form of butter. Most nut and seed spreads have a similar structural composition in which plant cell fragments are suspended in the oil extracted from nuts or seeds during grinding [32, 33]. Acceptability of nut butters is highly related to their consistency and appearance. Rheology deals with the deformation and flow of matters when exposed to strain and stress. Rheological data could well determine effectiveness of various compounds in product development, food texture (association with sensory data), and final product control. In addition, the data determines engineering requirements for processing equipment, such as pumps, heat exchangers, and mixers. Several studies have been conducted on rheological attributes of semi-solid pastes, like peanut butter [34].

Abegaz and Kerr (2006) reported that addition of honey changed peanut butter flavors and viscosity [35]. Rheological attributes of two types of commercial peanut butters were studied by Citerne et al (2001) [34], according to whom, the mean volume diameter of the particle was found to be 6.6 µm. In addition, the two samples showed pseudoplastic behavior with the apparent yield stress of 24 and 370 Pa, respectively. The stabilized suspension demonstrated solid behavior. Besides, the elastic modulus was higher

than the loss modulus and was rather independent of the frequency.

Pistachios are considered highly valuable nuts grown in some countries, such as Iran. Its rheological properties have also been studied [36]. Pistachio butter made from ground and roasted pistachio kernels is a semi-solid paste with some flavors and sweeteners added to it to produce a high-quality foodstuff with a desirable texture and rheological attributes. Viscosity has a significant impact on the stability and overall quality of various foods, which is mainly affected by temperature in a fluid. Thus, temperature control appears to have a vital role in processing foods. Regarding food texture, some factors, including hardness, adhesiveness, and cohesiveness are usually determined using the Texture Profile Analysis (TPA) curve, especially in nut spreads, such as sesame. To create a product as healthy and nutritious as peanut butter, some modifications are made, such as optimization of roasting factors and the number of constitutes.

Emadzadeh et al (2013) studied effects of different types of fat replacers and sweeteners on viscoelastic and textural characteristics of pistachio butter [37]. They found out that dynamic moduli enhanced in the frequency sweep test with the loss tan value <1. As the temperature increased (5- 65°C), all samples showed viscous behavior according to the sweetener level and type of fat replacers.

Sunflower butter cookies are products evaluated as a function of different sweeteners, including honey [38]. Sunflower butter is a potential substitute for plant-based butters under high pH conditions in baking. Due to their effect on greening, sweeteners of low pH and high moisture, such as honey, should be used under such conditions.

Due to their nutritional properties and health-promoting effects, peanuts are among the most widely consumed crops worldwide, with an approximate annual production of 38 million tons [39]. Peanut oil has a protective role against free radicals owing to its well-balanced fatty acids and antioxidant content [40]. In addition, roasted peanut kernels are rich in antioxidants [41]. It should be noted that peanut consumption, even in the processed form, is beneficial to health because peanuts contain a balanced pattern of fatty acids, which ranges from 47 to 50%.

There is a high phenolic content (1–5%) in sunflower seed butter compared to other nut butters. In addition, it consists of chlorogenic acid (CGA) that includes 50-70% of its total phenols [42]. Sweeteners differ in their pH, phenolic content, and moisture, with these having an impact on overall acceptance of bakery products made from sunflower butter. The higher pH of the maple syrup than that of honey could lead to post-baking color reactions [43]. In fact, due to the higher amount of organic acids produced during

fermentation, honey solutions have a significantly lower pH when hydrogen peroxide is produced from glucose [44]. Compared to other sweeteners in this study, cookies made with honey had a higher pH and a lower rate of greening. In addition, they had more fragments than cookies made with the maple syrup.

Sensory and physical quality of nut pastes and similar products is affected by various rheological attributes, including viscosity [45, 46]. Peanut paste, for example, made from chopped kernels of different sizes was reported to be more viscous than that made from whole kernels [47]. In a study, some peanut soy spreads were produced using varying levels of isolated soy proteins, with soy nut butter and commercial peanut butter used as controls. Next, various textural attributes, including gumminess, adhesiveness, hardness, and cohesiveness of the treatments were measured. Based on consumer acceptance testing, peanut soy spreads and commercial peanut butter were considered acceptable, whereas commercial soy was not considered acceptable [48].

A randomized study showed that consumption of less than 60 g of a different form of peanuts, including honey-roasted peanuts, for a month led to a significant increase in the HDL cholesterol level and a decrease in the LDL cholesterol level [49]. To increase consumption of peanut butter, it was provided in the form of more attracting slices, like cheese, that were easy to rub on bread with enough shear-thinning texture for maintaining its shape [52]. The suggested peanut butter formulation included peanut butter 95.30%, gellan gum 2.4%, and paraffin wax 3.07 % at a cooling temperature of 22 °C and storage temperature of 4 °C. In the mentioned research, honey was mixed with milled sesame seeds, peanuts, and other materials. In addition, honey was heated to 70°C and maintained at this temperature for 15 min; next, it was added to the product to impart taste and composition. In the food industry, the proposed method could increase the shelf life of Halva (a sweet past) to 4 months.

Honey is added to carrot-cucumber jam as a sweetener to create a product that is a good source of energy. Honey is suitable for different age groups, diabetic patients, and obese people. Since some health benefits and nutritional components are lost in the postharvest phase in these two vegetables, processing them into jam sweetened with honey could have various benefits. Accordingly, the product could be stored easily and appealing to customers. This study showed that the product displayed a pseudo-plastic behavior, and the rheological behavior of the product was well described by the power law model.

In 2014, the US earned approximately $2 billion for the retail sales of nut and seed spreads, which accounted for almost half

of the value of all spreads. This also included goods, such as chocolate spreads, honey, jams, and preserves [50].

Research on rheological properties of tahini and blends containing it has increased markedly. A study by Abu-Jdayil et al on rheological properties of tahini as a function of the shear rate, shearing time, and temperature revealed that the steady shear behavior of the product was pseudoplastic, and the time-dependent behavior was thixotropic. Honey added to sesame paste affects its rheological properties. Research reported that within a temperature range of 20-70 and the shear rate range of 0.13-500 s-1, the honey-sesame paste product was pseudoplastic [51].

Due to the sweetening effect of honey, it is considered a favorable extra ingredient. However, the challenge posed is associated with difficulties occurring during product preparation as a result of its combined composition and stability during storage. Addition of honey to nut butter more than a certain amount could lead to a plastic product not readily mixed so that the resulting products could have undesirable texture and color. In some cases, the total amount of honey ranges from 3 to 30 wt% according to the total weight of the sweetened nut butter spread [52]. Billerbeck et al (1975) developed a method for improving the composition of peanut butter sweetened by about 5 wt% of honey. Their product consisted of roasted peanuts, fortifying materials, and some other additives. Besides, their objective was to provide a smoothly textured stable storage product with a desirable flavor [53]. Peanut butter is less commonly used due to some allergic issues in children. In recent years, there has been an increase in the use of cashew and almond butter in some modern countries, while the peanut butter market has declined [54]. Rheological properties of peanut butter have not been studied sufficiently, while several studies have been done on rheological characteristics of chocolates and honey. Soybeans have a high protein content, yet soy products have not achieved popularity due to the presence of the trypsin inhibitor, off-flavors, etc. Honey was an ingredient of soy butter (RSB) used in this research to examine the nutrient content, color, and sensory quality. To investigate quality factors of the optimization of the soy butter produced from sprouted soybeans, it was revealed that SB had a viscoelastic shear-thinning behavior and at lower shear rates, it behaved like a Bingham plastic, yet at higher shear rates, it behaved like a Herschel-Bulkley fluid.

Soybeans (Glycine max) containing 40/100 g of high-quality proteins with all essential amino acids are needed for growth [55]. They also contain many essential amino acids the human body is not able to produce. Soybeans have a variety of health benefits, including

prevention of CVD and cancer, as well as menopause treatment [56]. Glas (2006) reported that addition of a low-calorie sweetener to homemade soy butter decreased water activity but increased the overall quality compared to soy butter made with sugar [57]. Agrahar-Murugkar et al (2013) used sprouted and un-sprouted soybeans to produce soy butter [55]. Accordingly, the produced soy butter showed a viscoelastic shear thinning behavior and experienced a hysteresis loop. Compared to butter produced from un-sprouted beans, butter from sprouted beans showed a decrease in apparent viscosity, flow behavior, and the index particle size, while the consistency coefficient increased.

Conclusions

Recent technological advances and the raising consumer awareness of plant-based butters have led to the development of a variety of butters with nuts and seeds. Plant-based butters are a useful source of fiber, proteins, essential fatty acids, and other nutrients. Sweeteners, such as honey, could be used in nut pastes, nut butters, and nut spreads. Nut oils could be added to diets to effectively fight diseases, such as diabetes, CVD, and cancer through several biological mechanisms.

It was observed that an empirical power law model was suitable for describing the rheological behavior of most foodstuffs mixed with honey. Apparent viscosity of products containing honey changes with an increase in the shear rate. Moreover, the flow behavior index (n) and the consistency index (K) could change significantly, with all of them playing a key role in maintaining required physiochemical and rheological properties of the product.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this article.

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References

1- Eaton SB, Konner M. Paleolithic nutrition: A consideration of its nature and current implications. New England Journal of Medicine. **1985**;312(5):*283-9*.

2- Gorrepati K, Balasubramanian S, Chandra P. Plant based butters. Journal of Food Science and Technology. **2015**;52(7):*3965-76*.

3- Lifshitz F, Lifshitz JZ. Globesity: The root causes of the obesity epidemic in the USA and now worldwide. Pediatric Endocrinology Reviews: PER. **2014**;12(1):*17-34*.

4- Gunstone F. Vegetable oils in food technology: Composition, properties and uses: John Wiley & Sons; **2011**.

5- Shakerardekani A, Karim R, Ghazali H, Chin N. Textural, Rheological and Sensory Properties and Oxidative Stability of Nut Spreads-A Review. International Journal of Molecular Sciences. **2013**;14(2):*4223*.

6- Kwakman PH, Zaat SA. Antibacterial components of honey. IUBMB life. **2012**;64(1):*48-55*.

7- Chirife J, Zamora MC, Motto A. The correlation between water activity and% moisture in honey: Fundamental aspects and application to Argentine honeys. Journal of Food Engineering. **2006**;72(3):*287-92*.

8- Krell R. Value-added products from beekeeping: Food & Agriculture Org.; **1996**.

9- Samarghandian S, Farkhondeh T, Samini F. Honey and health: A review of recent clinical research. Pharmacognosy Research. **2017**;9(2):*121*.

10- Rao PV, Krishnan KT, Salleh N, Gan SH. Biological and therapeutic effects of honey produced by honey bees and stingless bees: A comparative review. Revista Brasileira de Farmacognosia. **2016**;26(5):*657-64*.

11- Khan RU, Naz S, Abudabos AM. Towards a better understanding of the therapeutic applications and corresponding mechanisms of action of honey. Environmental Science and Pollution Research. **2017**;24(36):*27755-66*.

12- McLoone P, Warnock M, Fyfe L. Honey: A realistic antimicrobial for disorders of the skin. Journal of Microbiology, Immunology and Infection. **2016**;49(2):*161-7*.

13- Almasaudi SB, El-Shitany NA, Abbas AT, Abdel-dayem UA, Ali SS, Al Jaouni SK, Harakeh S. Antioxidant, anti-inflammatory, and antiulcer potential of manuka honey against gastric ulcer in rats. Oxidative Medicine and Cellular Longevity. **2016**;2016.

14- Hossen MS, Ali MY, Jahurul M, Abdel-Daim MM, Gan SH, Khalil MI. Beneficial roles of honey polyphenols against some human degenerative diseases: A review. Pharmacological Reports. **2017**;69(6): *1194-205*.

15- Naseem E, Shamim M, Khan N. Cardioprotective effects of herbal mixture (ginger, garlic, lemon, apple cider vinegar & honey) in experimental animal models of hyperlipidemia. International Journal of Biological Research. **2016**;4(1):*28-33*.

16- Nguyen HTL, Katopo L, Pang E, Mantri N, Kasapis S. Structural variation in gelatin networks from low to high-solid systems effected by honey addition. Food Research International. **2019**;121:*319-25*.

17- Bambang N, Ikhsan M, Sukri N, editors. Rheological Properties of Honey and its Application on Honey Flow Simulation through Vertical Tube. IOP Conference Series: Earth and Environmental Science; **2019**: IOP Publishing.

18- Sopade P, Halley P, Bhandari B, D'arcy B, Doebler C, Caffin N. Application of the Williams–Landel–Ferry model to the viscosity–temperature relationship of Australian honeys. Journal of Food Engineering. **2003**;56(1):*67-75*.

19- Tanzi MG, Gabay MP. Association between honey consumption and infant botulism. Pharmacotherapy: The Journal of Human Pharmacology and Drug Therapy. **2002**;22(11):*1479-83*.

20- Abbès F, Bouaziz MA, Blecker C, Masmoudi M, Attia H, Besbes S. Date syrup: effect of hydrolytic enzymes (pectinase/cellulase) on physico-chemical characteristics, sensory and functional properties. LWT-Food Science and Technology. **2011**;44(8):*1827-34*.

21- Milani E, Koocheki A. The effects of date syrup and guar gum on physical, rheological and sensory properties of low fat frozen yoghurt dessert. International Journal of Dairy Technology. **2011**;64(1):*121-9*.

22- Mohamed IO, Babucurr J. Effect of date syrup on pasting, rheological, and retrogradation properties of corn starch gels. Starch-Starke. **2015**;67(7-8):*709-15*.

23- Portmann M-O, Kilcast D. Descriptive profiles of synergistic mixtures of bulk and intense sweeteners. Food Quality and Preference. **1998**;9(4):*221-9*.

24- Bodenheimer FS. The Coccoidea of Turkey III. Revue de la Faculté des Sciences de l'Université d'Istanbul (Ser B). **1953**;18:*91-164*.

25- Nikolopoulos C. Morphology and biology of the species Marchalina hellenica (Gennadius)(Hemiptera Margarodidae Coelostomidiinae). Ecole de Hautes Etudes Agronomique des Athenes, Laboratoire Zoologie Agronomie et Serie, Athens, Greece. **1965**.

26- Akbulut M, Ozcan MM, Çoklar H. Evaluation of antioxidant activity, phenolic, mineral contents and some physicochemical properties of several pine honeys collected from Western Anatolia. Int J Food Sci Nutr. **2009**;60(7):*577-89*.

27- Akbulut M, Saricoban C, Ozcan MM. Determination of rheological behavior, emulsion stability, color, and sensory of sesame pastes (tahin) blended with pine honey. Food and Bioprocess Technology. **2012**;5(5):*1832-9*.

28- Shakerardekani A, Karim R, Ghazali HM, Chin NL. The effect of monoglyceride addition on the rheological properties of pistachio spread. Journal of the American Oil Chemists' Society. **2013**;90(10):*1517-21*.

29- Bolling BW, Chen C-YO, McKay DL, Blumberg JB. Tree nut phytochemicals: composition, antioxidant capacity, bioactivity, impact factors. A systematic review of almonds, Brazils, cashews, hazelnuts, macadamias, pecans, pine nuts, pistachios and walnuts. Nutrition Research Reviews. **2011**;24(2):*244*.

30- Alasalvar C, Shahidi F. Tree nuts: composition, phytochemicals, and health effects. Boca Raton: CRC; **2008**. *326 p*.

31- Shahidi F, Miraliakbari H. Tree nut oils and byproducts: Compositional characteristics and nutraceutical applications. Nutraceutical Science and Technology. **2006**;5:*159*.

32- Marangoni AG. Organogels: An alternative edible oil-structuring method. Journal of the American Oil Chemists' Society. **2012**;89(5):*749-80*.

33- Rosenthal AJ, Yilmaz S. Possible mechanism behind the hard-to-swallow property of oil seed pastes. International Journal of Food Properties. **2015**;18(9): *2077-84*.

34- Citerne GP, Carreau PJ, Moan M. Rheological properties of peanut butter. Rheologica Acta. **2001**;40(1):*86-96*.

35- Abegaz EG, Kerr WL. Effect of moisture, sugar and tertiary butylhydroquinone on color, texture and microstructure of peanut paste. Journal of Food Quality. **2006**;29(6):*643-57*.

36- Razavi S, Taghizadeh M, A. SA. Modeling the time-dependent rheological properties of pistachio butter. International Journal of Nuts and Related Sciences (IJNRS) **2010**;1:*38-45*.

37- Emadzadeh B, Razavi SM, Schleining G. Dynamic rheological and textural characteristics of low-calorie pistachio butter. International Journal of Food Properties. **2013**;16(3):*512-26*.

38- Liang S, Were LM. Chlorogenic acid oxidation-induced greening of sunflower butter cookies as a function of different sweeteners and storage conditions. Food Chemistry. **2018**; 241:*135-42*.

39- Bertioli DJ, Seijo G, Freitas FO, Valls JF, Leal-Bertioli SC, Moretzsohn MC. An overview of peanut and its wild relatives. Plant Genetic Resources. **2011**;9(1):*134-49*.

40- Shakerardekani A, Karim R, Ghazali HM, Chin NL. Oxidative stability of pistachio (Pistacia vera L.) paste and spreads. Journal of the American Oil Chemists' Society. **2015**;92(7):*1015-21*.

41- Win MM, Abdul-Hamid A, Baharin BS, Anwar F, Sabu MC, Pak-Dek MS. Phenolic compounds and antioxidant activity of peanut's skin, hull, raw kernel and roasted kernel flour. Pak J Bot. **2011**;43(3):*1635-42*.

42- Wildermuth SR, Young EE, Were LM. Chlorogenic acid oxidation and its reaction with sunflower proteins to form green-colored complexes. Comprehensive Reviews in Food Science and Food Safety. **2016**;15(5):*829-43*.

43- Ball DW. The chemical composition of maple syrup. Journal of Chemical Education. **2007**;84(10):*1647*.

44- Da Silva PM, Gauche C, Gonzaga LV, Costa ACO, Fett R. Honey: Chemical composition, stability and authenticity. Food Chemistry. **2016**; 196:*309-23*.

45- Shakerardekani A, Karim R, Vaseli N. The effect of processing variables on the quality and acceptability of pistachio milk J Food Process Pres. **2013**;37(5):*541-5*.

46- Shakerardekani A, Shahedi M. Effect of soapwort root extract and glycyrrhizin on consumer acceptance, texture, and oil separation of pistachio halva. Journal of Agricultural Science and Technology. **2015**;17(6):*1495-505*.

47- Santos B, Resurreccion A. Effect of particle size on the quality of peanut pastes. Journal of Food Quality. **1989**;12(2):*87-97*.

48- Dubost N, Shewfelt R, Eitenmiller R. Consumer acceptability, sensory and instrumental analysis of peanut soy spreads. Journal of Food Quality. **2003**;26(1):*27-42*.

49- McKiernan F, Lokko P, Kuevi A, Sales RL, Costa NM, Bressan J, Alfenas RC, Mattes RD. Effects of peanut processing on body weight and fasting plasma lipids. British Journal of Nutrition. **2010**;104(3):*418-26*.

50- Tanti R, Barbut S, Marangoni AG. Oil stabilization of natural peanut butter using food grade polymers. Food Hydrocolloids. **2016**;61:*399-408*.

51- Abu-Jdayil B, Al-Malah K, Asoud H. Rheological characterization of milled sesame (tehineh). Food Hydrocolloids. **2002**;16(1):*55-61*.

52- Liu L, Swain RB. Sweetened nut butter spread and method for its production. Google Patents; **2006**.

53- Billerbeck FW, Everett LH, Mcgowan PG, Pettinga PV. Sweetened storage stable peanut butter spread. Google Patents; **1975**.

54- Tong Q, Zhang X, Wu F, Tong J, Zhang P, Zhang J. Effect of honey powder on dough rheology and bread quality. Food Research International. **2010**;43(9):*2284-8*.

55- Agrahar-Murugkar D, Kotwaliwale N, Kumar M, Gupta C. Effect of sprouting on rheological properties of soy-butter. LWT-Food Science and Technology. **2013**;54(1):*95-100*.

56- Barrett JR. The science of soy: what do we really know? Environmental Health Perspectives. **2006**;114(6): *A353-A8*.

57- Glas J. The Effect of Varying Amounts of Sucralose in Homemade Soy Nut Butter on Palatability and Taste Preference. **2016.**