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PRODUCTION OF QUINCE JAM WITH *GINKGO BILOBA* EXTRACT AS A PECTIN SUBSTITUTE: EFFECTS ON PHYSICOCHEMICAL, MICROBIOLOGICAL, RHEOLOGICAL AND SENSORY QUALITIES

Ahsen Rayman Ergün[1*], Yeliz Tekgül[2]
[1]Ege University, Engineering Faculty, Food Engineering Department, Bornova, İzmir, Turkey.
[2]Aydın Adnan Menderes University, Köşk Vocatinoal School, Food Processing Departmant, Köşk, Aydın, Turkey.

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ABSTRACT
In this study *Ginkgo biloba* leaf extract which is rich in phytochemical metabolites was used as a pectin substitute in quince jam. The extraction process was performed ultrasonically at 70°C with ethanol that gives the highest flavonoid content. The jam was produced with pectin in the traditional procedure and pectin-free jams were made using two different weight concentrations (0.05% and 0.1%) of *Ginkgo biloba* extract and compared to the pectin group. Shear stress value decreased when *Ginkgo biloba* was used as a pectin substitute so the jam becomes softer. Phenolic content 170.09 (mg/g GAE), and antioxidant activity (1.80 mM Trolox/100g) was found highest in the 0.1 g extract group. Lightness and yellowness increased with *Ginkgo biloba* compared to the pectin group. The jam sample with 0.1 g extract was preferred in sensory tests.
Keywords: *Ginkgo biloba*, ultrasonic extraction, quince jam, antioxidant, rheological behaviour

PEKTİN İKAMESI OLARAK GINKGO BILOBA ÖZÜ İLE AYVA REÇELİ ÜRETİMİ: FİZİKOKİMYASAL, MİKROBİYOLOJİK, REOLOJİK VE DUYUSAL KALİTE ÜZERİNE ETKİLERİ

ÖZ
Bu çalışmada ayva reçelinde pektine ikame olarak fitokimyasallar açısından zengin olan *Ginkgo biloba* yaprağı ekstraktı kullanılmıştır. 70 °C'de etanol ile ultrasonik ekstraksiyon sonucu en yüksek flavonoid içeriğine ulaşılmış ve ekstraksiyon işlemi bu parametrede gerçekleştirilmiştir. Reçel geleneksel yöntemle pektin ile üretilmiş ve *Ginkgo biloba* ekstraktının iki farklı konsantrasyonunda (%0.05 ve %0.1) pektinsiz üretilen reçel grubu geleneksel üretim grubu ile karşılaştırılmıştır. Pektine ikame olarak *Ginkgo biloba* kullanıldığında reçelin kayma gerilimi değeri azalmış ve reçel daha yumuşak olmuştur. Fenolik madde içeriği 170.09 (mg/g GAE) ve antioksidan aktivite (1.80 mM Trolox/100g) 0.1 g ekstrakt grubunda en yüksek bulunmuştur. Pektin grubuna kıyasla *Ginkgo biloba* ile parlaklık ve sarılık değerlerinde artış saptanmıştır. Duyusal testlerde 0.1 g ekstrakt içeren reçel örneği tercih edilmiştir.
Anahtar kelimeler: *Ginkgo biloba*, ultrasonik ekstraksiyon, ayva reçeli, antioksidan, reolojik davranış

[*] *Corresponding author* / Yazışmalardan sorumlu yazar
✉: ahsenrayman@hotmail.com ✆: (+90) 232 311 3042 🖷: (+90) 232 311 4831

Ahsen Rayman Ergün; ORCID no; 0000-0003-0943-1950
Yeliz Tekgül; ORCID no: 0000-0001-8173-023X

INTRODUCTION

Quince, (*Cydonia oblonga* Mill.) which belongs to the Rosaceae family, is a subtropical fruit grown in Europe and Mediterranean countries. Turkey is the country with the highest production rate of quince (189.251 tonnes) (TÜİK, 2020). Because of its hardness and sourness, it is not consumable when raw. Most of the harvested quince fruits are processed into jam, marmalade, liquor, jelly, and candy (Wojdylo et al. 2013).

Jam production is a traditional food preservation method. Home-made jam is prepared by evaporating fruit puree with sugar. Acid, pectin, and other ingredients (coloring, flavouring, preservatives) can be used in the commercial jam (Baker et al. 2005). According to the Codex standards, total soluble solids of jams should be at least 60% (Anon 1981). High sugar content, low water activity, increasing acidity cause the shelf life of the jam to be extended (Garrido et al. 2015). Despite osmotic dehydration, some types of bacteria, mold, and yeast can survive in jams (Pascual & Calderon, 2000). In order to prevent microbial activity, several researchers recommend the use of some plant extracts in jam. The addition of pomegranate, lemon, rosemary, and aloe vera extracts in jams increases the stability of the product during storage (Gómez et al. 2013, Kim 2005).

In the industrial manufacture of jam, adding approximately 0-10 g/kg commercial pectin may be needed to provide constant gel strength (Vibhakara and Bawa 2006). Pectin is a heteropolysaccharide that is extracted from the plants' cell walls (Sulieman et al. 2013).

Citrus peels and apple pomace are mainly used as commercial pectin sources. There are also studies on the gelling characteristics of some fruit and vegetable powders (baobab, mango, ambarella, peach, pomegranate, sapodilla) that can be used as a substitute for commercial pectin in jam production (Koubala et al. 2012, Ndabikunze et al. 2011, Siddiqui et al. 2015).

Additionally, *Ginkgo biloba* (GB) contains many polysaccharides such as mannose, rhamnose, glucuronic acid, galacturonic acid, galactosamine, glucose, galactose, xylose, arabinose, and fucose similar to a standard monosaccharide content (mannose, glucosamine, ribose, rhamnose, glucuronic acid, galacturonic acid, galactosamine, glucose, galactose, xylose, arabinose, and fucose) (Chen et al., 2012; Fang et al., 2020). Owing to these contents it has the ability of gel making property.

Ginkgo biloba is a type of tree used in medicine (Chan et al. 2007). Clinical studies reveal that it is effective in the treatment of diseases such as cancer, diabetes, dementia, thrombosis, Alzheimer's, ischemic heart disease, hypertension (Birks et al. 2009, Vellas et al. 2012, Biggs et al. 2010, Brinkley et al. 2010, Kuller et al. 2010). It is consumed as a dietary supplement as it contains different phytochemical metabolites such as terpenoids, steroids, flavonoids, glycosides, alkaloids, and lignans (Mei et al. 2017, Su et al. 2009). G*inkgo biloba* leaf polysaccharide has also been used as the reducing and stabilizing agent and also used in preparing candy and beverages (Fang et al., 2020). In addition, it is reported *that Ginkgo biloba* leaf extract shows antimicrobial activity against various pathogens because of its chemical structure (Yuan et al. 2019). There are several studies about quince jam quality (Ferreira et al. 2004, Silva et al. 2002).On the other hand, G*inkgo biloba* food supplement has been studied, as well (Czigle et al. 2018, Fransen et al. 2010). However, to our knowledge, using G*inkgo biloba* in jams has not been researched yet. The aim of this study was to research the effect of the addition of two different concentrations of G*inkgo biloba* extract in quince jam, on the physicochemical (soluble solid content, pH, acidity, color, total phenolic and antioxidant content), microbiological (osmophilic mold and yeast count), rheological and sensory properties (color, texture, odor, flavor, and general appeal).

METHODS

Jam materials

Fresh quince (*Cydonia oblonga* Mill.) samples were purchased from a market in Aydın (Turkey). Dried *Ginkgo biloba* leaves were obtained from

Arpaş Arifoğlu Food Ind. (Istanbul, Turkey) and stored at 20 °C until extraction procedures.

Chemicals

Folin-Ciocalteu reagent and gallic acid were purchased from Merck Co. (Darmstadt, Germany). Citrus peel pectin (74% degree of esterification), Trolox, were obtained from Sigma Chemical Co. (St. Louis, Mo, USA). All other reagents were at analytical grade.

Extraction procedure

Ginkgo biloba leaves were ground in a laboratory-type grinder (Sinbo-SCM 2934, Turkey). Three different solvents (75% ethanol, 75% methanol and ultrapure water), and two different extraction parameters (15 and 30 min) were tested for the total amount of phenolic and flavonoid contents.

1 g sample was put in a flask and filled with extraction solvent (75% ethanol) to 50 mL. The extraction process was performed at 30 °C for 30 min with an ultrasonic device (Sonorex Super RK-106, 35 kHz, 480 W, Germany). After the ultrasonic extraction, the slurry was transferred to falcon tubes and centrifuged at 4500 rpm for 15 min with a centrifuge (Hettich EBA 21, Germany). The centrifuged samples were filtered. All extracts were stored at 4 °C (Akbulut et al., 2021).

Jam production

Quince jams were prepared according to the extra-traditional procedure taking into the limits in the Turkish Food Codex (Anon, 2010). The raw quinces were washed, peeled, and sliced. Fruits were boiled in hot water (4:1, weight: weight w/w) at 100 °C for 5 min. 250 g of boiled fruit and 305.5 g of sugar were used to prepare quince jam. The boiled fruit and sugar were boiled in an open vessel. A pectin-free group was prepared as a control. The production of pectin-free jams was done using two different concentrations (0.05% and 0.1%) of G*inkgo biloba* extract and also a group was produced with commercial pectin (0.8%). Citric acid solution (10%; w/v) was used to adjust the pH value to approximately 3 for all groups. The boiling was continued until the total soluble solids value reached 68 °Bx. A digital refractometer (MA871, Hanna Instruments Ltd, UK) was used to determine total soluble solids. Hot quince jam samples were poured into sterilized jars and kept in the refrigerator until analysis.

Methods of analysis

pH measurement

A digital pH meter (inoLab 7110, WTW, Germany) was used to measure the pH values of quince jams.

Titratable acidity analysis

Quince jam samples were homogenized using a blender (Waring 8010S/G, Malaysia). 10 g sample was diluted with 100 ml distilled water then filtered. The filtrate (20 ml) was titrated with 0.1 N NaOH (Cemeroğlu, 2010). Results were expressed as citric acid % (w/g) according to the following equation (1).

$$Total\ titrable\ acidity\ (\%) \frac{V*F*E*100}{m} \tag{1}$$

V: volume of the consumption
F: factor of the NaOH
m: the amount of the sample (g)
E: the amount of equivalent acid

Color analysis

The color values of quince jams were obtained using a chromameter (CR-10, Konica Minolta, Japan). The device has been calibrated according to the standard white line (Y=93.9, x=0.313, y=0.321), *L** (bright), *a** (red-green), and *b** (blue-yellow) values were measured (Zor and Şengül, 2020).

Antioxidant activity analysis

In order to determine the antioxidant activity and total phenolic content, the first samples were extracted. For this reason, 25 mL of methanol:water (50:50 v/v) was added to the samples weighed 5 g in centrifuge tubes. After the treatment of 10 minutes in an ultrasonic water bath (Everest Ultrasonic, Turkey). After centrifugation for 20 minutes at 8500 rpm and 4 °C in a centrifuge (Hettich Universal 320, Germany). The supernatant on the centrifuge tubes was collected and stored in glass bottles until analysis at 20°C (Şengul et al., 2018).

The total antioxidant activity of jams was measured by the 2,2-Azino-bis-(3-ethylbenzo-thiazoline-6-sulfonic acid) (ABTS) assay (Re et al. 1999). ABTS $^{+}$ radical cation reduction capacities were expressed as % inhibition. The antioxidant capacity of samples was measured according to a calibration curve that was formed using Trolox at 734 nm. Results were expressed as mM Trolox/100g.

Total phenolic compound analysis

The same extraction procedure was made before the analysis mentioned previously in the antioxidant activity analysis part. Total phenolic compound concentration was measured as stated in Singleton and Rossi (1965) using Folin & Ciocalteau reagent. The absorbance was measured at 760 nm. Various concentrations of gallic acid solution were used to plot a calibration curve. Results were expressed as mg/100g gallic acid equivalent (GAE).

Microbiological analysis

Jam samples were stored 15 days at two different temperatures (4±2 ˚C and 20±2 ˚C) for following the microbiological growing (Randazzo et al., 2013; Rababah et al., 2014; Zor and Şengül, 2020). It was determined in previous researches that no longer growth was seen after 15 days. For microbiological analysis, 10 g samples were homogenized with a stomacher for 1 min after the addition of 90-ml diluent. Malt Extract Agar (MEA, Merck, pH 5.4–5.8) containing 40% sucrose was used to determine osmophilic mold and yeast counts. After the inoculation of plates using the pour plate technique, they were incubated at 25 °C for 3–5 days. At the end of the incubation period, mold and yeast colonies were counted (Pitt and Hocking, 2009).

Rheological analysis

The rheological measurements of quince jam samples were performed using a controlled-viscometer (Brookfield LVDV-II, USA) with a spindle (S-25 and 31) and its rotational speed of 0.0–200 rpm and between 0 and 100% full-scale torques. During the rheological measurement, shear stress (SS), shear rate (SR), viscosity (cP), and % torque (T) values were recorded for each rotational speed (rpm). The experiments were carried out in duplicate.

Measuring sensory attributes

The sensory test was performed with semi-trained 9 panelists. All samples were given at room temperature with coded in three-digit numbers randomly. The panelists scored the samples with a hedonic rating scale from 1 to 5 (1=like very much 2=like 3=like moderately 4=dislike 5=dislike very much) indicating increasing general appeal level in the 0.05 significance scale (Altuğ and Elmacı, 2011).

Statistical analysis

Statistical evaluation of data was performed with the software SPSS (version 20, SPSS Inc., Chicago, IL, USA). Duncan's multiple comparison test was used to determine the difference between means. The production was made in two replicates and all of the analyses were replicated 3 times.

RESULTS

Determination of the extraction parameters

Three different solvents (75% ethanol, 75% methanol, and ultrapure water) and two different extraction parameters (15 and 30 min) were tested for the total amount of phenolic and flavonoid contents. The results were given in Table 1. The highest phenolic content was found in methanol extraction. But the flavonoid extraction was highest with 75% ethanol. Ethanol which is also more suitable for human health (Karahan, 2017), was selected for ultrasound extraction. 30 min extraction process was completed optimally with ethanol.

Evaluation of physical and chemical quality

Soluble solid content, antioxidant activity, phenolic contents, acidity, pH, and color values were measured and compared within groups after production (Table 2). Soluble solid contents were the same for all sample groups and suitable for the TS 4188 the standard of quince jam as 68% (Anon, 2010). The production was made until the same °Brix value.

Table 1. Total flavonoid and phenolic contents after extraction pretreatments.

	Extraction time (min.)	Total phenolic content (Mg GAE/L)	Total flavonoid content (Mg QE/L)
%75 Ethanol	15	545.36^{b,e}	688.98^{a,g}
%75 Ethanol	30	571.06^{2,d}	756.78^{1,f}
%75 Methanol	15	585.99^{a,e}	530.09^{b,g}
%75 Methanol	30	611.90^{1,d}	574.57^{2,f}
Ultra Pure Water	15	434.24^{c,d}	318.22^{c,g}
Ultra Pure Water	30	433.42^{3,e}	373.31^{3,f}

$^{a\text{-}c}$ symbolized the difference within the columns at different solvents for 15 min extraction time ($p < .05$).
$^{d\text{-}e}$ symbolized the difference within the columns at different times for total phenolic content ($p < .05$).
$^{f\text{-}g}$ symbolized the difference within the columns at different times for total flavonoid content ($p < .05$).
$^{1\text{-}3}$ symbolized the difference within the columns at different solvents for 30 min extraction time ($p < .05$).
GAE is referring to the Gallic acid equivalent.
QE is referring to Quercetin equivalent.

The acidity values were given in Table 2 and were significantly differ between each group ($P < 0.05$). In this study, acidity values were increased when GB extract was used. Similar to this study, in jam processing, the effect of heat decreased pH values and increased acidity (Bekele et al., 2020; Rababah et al., 2012). This can be explained by the hydrolysis of the GB extract due to heat. Nakanishi (2005) reported that ginkgolides and bilobalides were the major constituents of GB extract. Ginkgolides were biosynthesized through the glyceraldehyde-pyruvate pathway. Ginkgolides were bitter taste and also volatile.

pH values were found as 3.05, 3.3, 3.12, and 3.21 respectively for the groups of control, pectin, 0.05 g, and 0.1 g GB. In jam production pH value is needed to be between the 3.0-3.5 values for a targeted gel occurrence (Kılıç et al. 1987). Additionally, the TS 4188 standard of quince jam (Anon, 2010) prescribed that it should have a pH value of 2.8-3.6. pH and acidity values were found in previous researches as 3.13, 0.36% (Zor and Şengül, 2020) and as 3.32-3.48, 0.21-0.39 g/100 ml (Yılmaz, 2007), respectively. These values were in agreement with the standard and also with our study. Total acids as citric (%) were found as 0.30-0.41. It was reported by Roy et al. (2018), the pH values of jams ranged between 2.62 to 3.34. pH was also effective on the color of the jam as mentioned in a study as the pH values were lower, the color values became higher and the color of the jam was pinker (Kuwada et al., 2013).

In this study, color values such as brightness were increased in the GB groups compared to the pectin group ($P \leq 0.05$) parallel with the increase in the concentration of the GB extract. Redness decreased whereas yellowness (b^*) increased. But there were no significant differences between the yellowness of control, pectin, and 0.05 GB group ($P < 0.05$). This could be due to the original color of the extract and during the heating process, the extract did not cause the browning and/or deterioration in the appearance of the jam. When the literature examined for quince jam it was seen that Zor and Şengül (2020) determined the L^*, a^*, and b^* values as 35.91, 8.20 and 12.35 respectively for the quince jam. Wojdyło et al. (2013) detected the color values of the jams prepared from quince fruits as L^*=50.7, a^*=0.1, and b^* as 18.2. They stated that the color values L^*, a^*, and b^* were differed in mixed jam samples. They found no significant difference between the lightness of quince jam and jam with flowering quince. There are lots of studies about fortifying the jam with dietary fibres such as Igual et al. (2014), studied with the bamboo fibre and this makes the color of osmotic dehydration of grapefruit jams similar to the fresh ones. In agreement with this idea, Falcão et al. (2009) emphasized that the consumer preference changed with the color of food products and temperature changes and caused losses in this critical factor. The pectin was used in the traditional jam process for providing gel but needs high temperatures for gel-forming. So the color loss was seen at high temperatures.

They also explained these differences in the luminosity with the cooking and concentration. Maillard reactions and caramelization of sugars result in a dark product at long times and high temperatures. Differently, Roy et al. (2017) studied with pectin from pomelo peel in carrot jam found that color loss was lower in jam prepared with pomelo pectin than that made with commercial pectin, and the concentration of pectin was inversely changed with the color. They also associated this consequence with the variation in phenolics. Antioxidant activities were increased by the *Ginkgo biloba* extract significantly (P >0.05) and found at most in the sample of 0.1 GB as 1.80 (mM Trolox/100g). This plant is known for its rich antimicrobial and antioxidant property.

Table 2. Quality characteristics of jams with different gelling agents

Quality parameters	Sample groups			
	Control	Pectin	0.05 GB	0.1 GB
pH	3.50±0.15^{a}	3.30±0.02^{a}	3.12±0.01^{a}	3.21±0.00^{b}
Acidity (%)	0.39±0.80^{a}	0.41±0.04^{a}	0.46 ±0.02^{a}	0.57±0.02^{b}
L^*	48.00±0.46^{a}	48.21±0.20^{a}	49.53±0.12^{b}	54.68±0.08^{c}
a^*	4.12±0.17^{a}	4.07±0.09^{a}	1.88±0.15^{b}	3.79±0.05^{c}
b^*	27.03±0.93^{a}	27.47±0.56^{a}	28.61±0.77 ^{a}	30.12±0.10^{b}
Antioxidant Activity (mM Trolox/100g)	0.49±0.50^{a}	0.47±0.00^{a}	0.85±0.01^{b}	1.80±0.01^{c}
Total Phenolic Compounds (mg/kg db^{-1} GAE)	166.30±3.12^{a}	173.00±2.09^{a}	497.02±7.90^{b}	870.09±3.16^{c}

$^{a\text{-}c}$ Means within each line followed by a different letter are significantly different (P <0.05)
GAE: Gallic acid equivalent, GB: Gingko biloba

The antioxidant activity of sample groups with GB also increases in parallel with the increasing concentration of the extract as expected. Similarly, Maltaş (2011) reported that *Ginkgo biloba* is a good source for phenolics and hence for antioxidant compounds. Phenolic compounds were found as 166.3, 173, 497.02, and 870.09 mg/kg db^{-1} GAE respectively for the jam samples produced as control, pectin, 0.05 GB, and 0.1 GB groups. There was a statistical significance between the phenolic contents of GB and control groups ($P \leq 0.05$). The increase was approximately 7 times between the pectin group and 0.05GB group. It is worth mentioning that this result is very important for the consumer's health. Phenolics have an important role in antioxidants which reduces the risk of many diseases by reducing oxidative stress (Slinkard and Singleton, 1977). It was previously stated that the total polyphenolic compounds in quince jam were 484.5 mg/100g. They indicated that the phenolic compounds in this sample contain flavan-3-ols mostly (77.3% of total phenolic compounds), then proanthocyanidins with the ratio of 63.4%, and at least (11% and 7.8% of total phenolic compounds) hydroxycinnamic acids, especially neo chlorogenic and chlorogenic acid, respectively (Wojdyło et al., 2013). In jams prepared by Silva et al. (2004a), the content of phenolic compounds was found as 134.1mg/100g and 357.1mg/100g the jams were made from peeled and unpeeled quince fruits respectively. The traditional type of jams has ascorbic acid content as % 3.88 whereas the ascorbic acid content was found %2.16 in the industrial type of jams.

Evaluating steady-state and time-dependent rheology

Viscoelastic properties of the products are crucial for conceiving their behavior during the process, storge and, consumption (Augusto et al., 2013). The consistency of jellies, marmalades, and jams had significance in the consumption. In this study, the effect of the addition of *Ginkgo biloba* to quince jam on rheological behavior was investigated. Rheological properties were evaluated and the experimental shear stress versus shear rate rheograms was determined in Figure 1. The shear rate was varied between 3.4 to 68 s^{-1}. It was found that the samples showed nearer to Newtonian fluid (shear thinning) behavior whereas the pectin sample showed a pseudo-plastic behaviour. The shear stress of the jams increased as the shear rate increased. Tiwari et al. (2016), informed in their study in detail how to decide the rheological behaviour of the food. The classification was made due to the flow curve (shear stress v/s shear rate). If it is linear and passes through the origin is said to be Newtonian. When the flow curve either does not passes through origin or is non-linear, the material is said to be Non-Newtonian. Basu and Shviare (2013) stated that when the shear rate increases, apparent viscosity decreased confirming the non-Newtonian behavior of jam samples. Álvarez et al. (2006), studied different jams such as strawberry, raspberry, prunes, peach, and apricot and found non-newtonian pseudoplastic behaviour. Additionally, apparent viscosity and shear rate were evaluated. It was found that the apparent viscosity decreased as the rate of shear increased in Figure 1. The apparent viscosity of the jams increased with the increase of extract concentration (P <0.05). Moreover, viscosities were decreased from pectin to 0.05 GB sample with the increase in pH values. Falcão et al. (2009), performed the apparent viscosity values as a function of increasing shear rate for the different jams. They decided that the jams were non-Newtonian fluids and showed pseudoplastic rheology, they indicated that an important characteristic of the apparent viscosity/shear rate ratio is the occurrence of hysteresis. Tiwari et al. (2016) observed that the curve was close to each other and the loop area was small enough to neglect the thixotropy and they found the jackfruit jam as viscoplastic. Furthermore, Kayacier and Dogan (2006) increase in the shear rate decreases the apparent viscosity.

These results were confirmed with Basu and Shivhare (2013), produced mango jam and detected a decrease in apparent viscosity with increasing shear rate demonstrated the non-Newtonian behavior. Barbieri et al. (2018) also explained the situation why the shear stress rheogram begins far from the initial point of the shear stress/shear rate plot and is concaved downwards. This was because of yield stress during the flow of a material which provides a cross linked structure or other interactive structure that should be corrupted before the flow begin with the convenient rate (Canet et al., 2005, Sun and Gunasekaran, 2009).

Shear stress versus time for the groups was given in Figure 1. They also mentioned that shear stress decreased depending on time (Basu and Shivhare, 2013). Similarly, Sabancı et al. (2016), showed that the time, temperature, and shear rate affected the rheological properties of koumiss. Falcao et al. (2009), studied with the jam model system and they observed that when the temperature increased, the consistency also increased. In addition, linear viscoelastic properties and viscosities increased with pectin concentration (Díaz-Ocampo et al., 2014).

Evaluation of microbiological quality

Jam samples were stored 15 days at two different temperatures (4±2 °C and 20±2 °C) for following the microbiological growing (Randazzo et al., 2013; Rababah et al., 2014). It was determined in previous researches that no longer growth was seen after 15 days. At the beginning of the storage (zero-day) and the end of 15 days, osmophilic mold and yeast counts were below the detection limit of <1.0 log CFU/g of the samples.

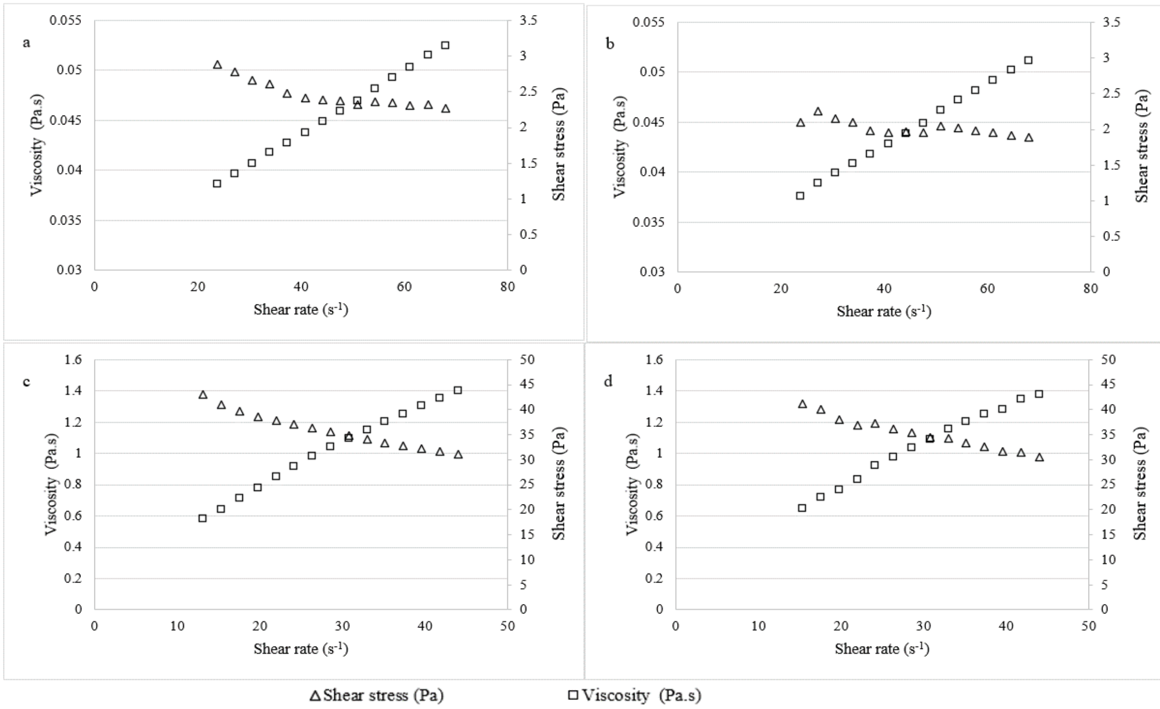

Figure 1. Rheograms of quince jam groups as 0.1GB, 0.05 GB, control, and pectin.
* Graphs a, b, c, and d show the rheograms of quince jam groups as 0.1GB, 0.05 GB, control and pectin respectively.

Likewise, the microbial load in stored jackfruit jam was evaluated by Tiwari et al. (2016) found that samples were stable on storage and no colonies were detected at the end of 16 months at 7°C. It was already denoted that the low pH and high sugar content are critical for the quality during storage, inhibition of the growth of molds and yeasts and assure satisfactory setting of the marmalade such as the marmalade produced by fluted pumpkin fruit was found stable with no mold count at 52–56°C (Egbekun et al., 1998). Ferreira et al., (2004) supported this situation by presenting a total number of yeast and mould in quince jam higher than 10 CFU/g due to a lower Brix value lower than 63%.

Evaluation of sensory quality

Quince jams were tested for color, texture, odor, flavor, and general appeal 1 to 5 via to liking level. Figure 2 shows the average scores for the jam samples. 0.1 GB extract sample was liked mostly by the panelists in terms of the color, texture, flavor, and general appeal properties. An only control sample was preferred regarding the general appeal. This demonstrated that panelists can consume easily this new product. The kinds and amount of constituents change the food texture and the consumers can easily notice these differences when tasting with a mouthfull. In previous researches, a hedonic test was conducted generally to jam samples and it was reported that panelists give importance to color firstly rather than other attributes such as Garrido et al. (2015) who studied with apple jelly stated that consumers give attention to taste and color rather than textural properties.

They scored between 3.6-6.2 in the 9 scales hedonic test. In another study, Basu and Shivhare (2013) investigated the properties of mango jam. They obtained that increased pectin concentration and acidity caused hardness and these groups were not preferred. They made a hedonic test similar to our study and the overall acceptability scores increased by increasing pH and sugar concentration. Basu et al. (2013) researched the effect of sorbitol alternatives to sucrose and found that the scores in the sensory evaluation were higher for the sorbitol group than the scores for the jam manufactured with sucrose. Pérez-Herreraa et al., (2020) reported that adding the dietary fiber to jam caused an increase in gel strength and this reduced the acceptance. They suggested that it is useful to optimize the amount of constituents such as acid and sugar to provide acceptable jams with Physalis spp. fruit that also includes the seeds. As concluded sensory property of a new or fortified product was changeable with the amount of added material and optimization of these factors was important.

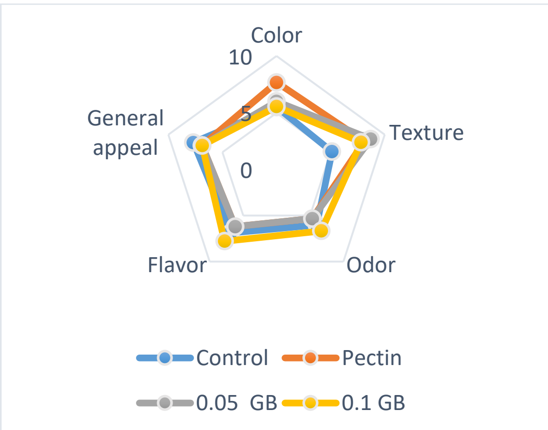

Figure 2: Average scores of the panelists for hedonic test on the quince jam groups as 0.1GB, 0.05 GB, control, and pectin

CONCLUSION

In this study, quince jam was produced by two different concentrations of Ginkgo biloba extract as a pectin substitute. Phenolic contents and antioxidant activity were significantly increased in parallel with the concentration of extract ($P \leq 0.05$). Rheological properties also differed from pectin. The panelists prefer the jam sample with 0.1 g GB extracts rather than the pectin added jam. The preferred jam sample with 0.1 g Ginkgo biloba extract by the panelists demonstrated that this extract can be used alternatively also for improving the sensory quality together with its benefits in chemical, physical, and microbiological attributes. In future studies, the synergistic effect of GB extract with other functional plant extracts on the quality of jams with fruits and vegetables can be researched.

CONFLICT OF INTEREST

There is no conflict of interest between the authors.

AUTHOR CONTRIBUTION

Ahsen RAYMAN ERGÜN, provided the production, analysis, evaluation of the results and writing of the manuscript. Yeliz TEKGÜL, planned the research, provided the evaluation of the analysis, and writing the manuscript. All authors contributed to the article and approved the submitted version.

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