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PREPARATION AND QUALITY EVALUATION OF ENRICHED SALAD DRESSINGS BASED ON COLD-PRESSED SAFFLOWER OIL

Emin Yilmaz,* Emine Bildi
Çanakkale Onsekiz Mart University, Faculty of Engineering, Department of Food Engineering, Çanakkale, Türkiye

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ABSTRACT
The objectives of this study were to prepare and characterize two different salad dressings based on cold-pressed safflower oil. Common physico-chemical and thermal properties, compositions, sensory descriptive analysis, and consumer tests were completed. Both samples had acceptable free fatty acidity, peroxide and pH values, and had color values reflecting the spices (red pepper and green spices). Both dressings were liquid at around -14 to -19 °C and were pourable. They were good sources of essential fatty acids, including around 91-92% of total unsaturated fatty acids. Total phytosterol contents were around 1693-1700 mg/kg, with a majority of β-sitosterol. Further, both samples had around 284 mg/kg of total tocopherols. The panel used 8 sensory terms (consistency, sweet, salty, sour, bitter, spicy, vinegary, and metallic) to describe the samples. Consumers liked their appearance and smell/aroma, but taste/flavor and general acceptance scores were lower. Further studies to improve taste properties are suggested.
Keywords: Salad dressing, safflower oil, spice, composition, sensory, consumer

SOĞUK PRESLENMİŞ ASPİR YAĞINDAN ZENGİNLEŞTİRİLMİŞ SALATA SOSLARININ HAZIRLANMASI VE KALİTE DEĞERLENDİRİLMESİ

ÖZ
Bu çalışmanın amacı soğuk-preslenmiş aspir yağından iki farklı tip salata sosu hazırlamak ve ürün karakterizasyonu yapmaktır. Yaygın fizikokimyasal ve termal özellikler, bileşim, duyusal tanımlama ve tüketici testleri tamamlanmıştır. İki örnek de kabul edilebilir serbest asitlik, peroksit ve pH değerleri ve katılan baharatın renklerini (kırmızıbiber ve yeşil baharatlar) göstermişlerdir. Her ikisi de -14'den -19 °C'ye kadar likit ve akışkandırlar. Esansiyel yağ asitlerinin iyi kaynağı oldukları ve yaklaşık %91-92 oranında toplam doymamış yağ asitleri içerdikleri belirlenmiştir. Büyük bölümü β-sitosterol olmak üzere 1693-1700 mg/kg toplam fitosterol içermektedirler. İlaveten, 284 mg/kg toplam tokoferol içeriği belirlenmiştir. Panelistler örnekleri 8 terimle (akışkanlık, tatlı, tuzlu, ekşi, acı, baharatlı, sirkemsi, metalik) tanımlamıştır. Tüketiciler örneklerin koku/aromasını beğenmiş, ancak tat/lezzet ve genel kabul skorları düşük bulunmuştur. Tat özelliklerini geliştirecek yeni çalışmalar önerilmiştir.
Anahtar kelimeler: Salata sosu, aspir yağı, baharat, bileşim, duyusal, tüketici

* *Corresponding author* / Yazışmalardan sorumlu yazar
✉: eyilmaz@comu.edu.tr ☎: (+90) 286 218 0018/20054 🖷: (+90) 286 218 0541

Emin Yılmaz; ORCID no: 0000-0003-1527-5042
Emine Bildi; ORCID no: 0000-0001-9030-7177

INTRODUCTION

Salad dressings are basically low-pH oil-in-water emulsion products, which may include some other ingredients and aromas, and could have various viscosity profiles. They have gained popularity as consumers go towards healthier eating with salads, aperitifs, side meals, vegetables, and other foods. Usually, salad dressings were poured onto these foods to make them more tasty and healthy. Consequently, salad dressings faced further research to improve their nutritional, technical, and sensory quality (Dickinson and Stainsby, 1982; Manshadi et al., 2019).

Food and Drug Administration (FDA) has defined salad dressings (21CFR169.150) as 'emulsified semisolid food prepared from any vegetable oil, acidifying agent (any vinegar, lemon, and/or lime juice), egg yolk, starchy paste (prepared from a food starch, food starch-modified, tapioca flour, wheat flour, and/or rye flour with water added), optional ingredients, (salt, nutritive carbohydrate sweeteners, any spice or natural flavoring, except if it imparts a yolk color), MSG, stabilizers and thickeners, up to 25% substitution of acidifiers with citric and/or malic acid, sequestrants (e.g., calcium disodium EDTA or disodium EDTA), and crystallization inhibitors (e.g., oxystearin, lecithin, or polyglycerol esters of fatty acids)'. Further, it was stated that salad dressings cannot contain less than 30% by weight of vegetable oil and 4% by weight of egg yolk (FDA, 2012). Similarly, the Turkish Standard for salad dressing (TS 7437) defines these products as 'salad dressing is a product made from vegetable oil, egg and/or egg products, acidifiers, fillers, one or more of the seasoning and other additives in different proportions according to the type of salad dressing which it has a thick consistency or a flowing consistency, produced in accordance with the technique in the form of stable emulsification from the mixture.' The standard identifies two types of salad dressings; the thick sauce is a spoonable produce with egg, cooked or partially cooked starch as filling containing sauces, and flowing sauces as the products which do not contain fillers, and homogenized, prepared with or without eggs (TSE, 1989). Further, the standard defines its taste and viscosity according to its sub-type as it is and puts limit technical values of min. 30% by weight of oil, min. 0.60% total acidity as acetic acid, max. 0.3% of free fatty acidity, max. 10 meq O_2/1000 g of peroxide value, pH value between 3.2 and 4.2, and min. egg content of 4% by weight (TSE, 1989).

In literature, there are different studies dealing with different recipe formulations to develop nutritious salad dressings (Mantzouridou et al., 2013; Manshadi et al., 2019), product quality and stability evaluations (Paraskevopoulou et al., 2007; Drakos and Kiosseoglou, 2008; Bortnowska et al., 2014; Sainsbury et al., 2016), sensory evaluations (de Melo et al., 2015; Sainsbury et al., 2016; Manshadi et al., 2019), rheological studies (Diftis et al., 2005; Martinez et al., 2007; Ma et al., 2013) and others. In this study, we aimed to use cold-pressed safflower oil as the oil source and cold-press Milk Thistle seed flour as the starchy material source to develop two different salad dressings with different spices. Cold-pressed oils are regulated by the Turkish Codex (TGK, 2012). These oils were produced from very safe and clean plant seeds or oil-containing plant parts by mild pressing to reduce oil exit temperature below 40 ^{o}C (for olive oil it is 37 ^{o}C) to keep their bio-actives intact. These oils are not refined. Due to the processing technology, cold-pressed oils contain high levels of bio-active molecules and have unique aromatics. Further, the press-cakes (meals) of cold-pressing are high quality with higher content of remaining oil, protein, and bio-actives and could be used in food formulations.

Evaluation of current research and consumer trends have pointed out that new salad dressings with nutritious ingredients and different tastes could offer consumers choices. Consequently, this study aimed to develop and evaluate two new salad dressings based on cold-pressed safflower oil and cold-pressed Milk Thistle seed press-cake (meal) and spice mixtures. Some physico-chemical, thermal, compositional, and sensory analyses were completed to evaluate the potential of the products.

MATERIALS AND METHODS

Materials

The cold-pressed safflower oil was purchased from Onevo Co. (Istanbul, Türkiye). The producer provided fatty acid composition was 0.2% myristate, 6.5% palmitate, 2.5% stearate, 13.0% oleate, 77.3% linoleate, 0.5% gadoleate with 1.10% of free fatty acidity and 10.2 meqO_2/kg oil peroxide value. The regular apple vinegar (min. 10% acetic acid), the dry spices (chili pepper, pimento, dry mint, and thyme), kitchen salt, and table sugar were bought from local stores. The egg yolk powder (Kor Agro Organik Gıda A.Ş., İzmir), food-grade Xantham Gum (As Kimya Co., İstanbul), Potassium Sorbate and EDTA (Sigma Chem. Co, St. Louis, US) were purchased. The Milk Thistle seed press-cake used was produced from our previous study (Ayduğan et al., 2022), and its composition was 4.2% moisture, 4.8% crude oil, 17.30% total protein, 4.10% ash, and 69.6% total carbohydrates. The chemicals and standards used were purchased from Sigma Chem. Co. (St. Louis, USA), and Merck (Darmstad, Germany).

Preparation of the Salad Dressings

The recipe formulations provided in Table 1 were used to prepare the salad dressing samples. First, the calculated amounts of aqueous phase components (vinegar, sugar, salt, xanthan gum, potassium sorbate, EDTA and Milk Thistle seed press-cake) were dissolved in water. Then, the egg yolk powder was dissolved in the safflower oil. Finally, the aqueous phase was slowly added to the oily phase with the spices mixtures and homogenized (Ultra Turrax, IKA T-25, Germany) first at slow rate (3000 rpm) for 2 min, then at a high rate (15000 rpm) for 8 min. Finally, the prepared dressings were placed into glass jars and closed before placing them into the refrigerator. During the analyses, the samples were stored in the fridge. The prepared samples can be observed in Fig. 1. The sample names and abbreviations indicated in Table 1 were used throughout the paper.

Table 1. The recipe formulations used to prepare the salad dressings

	Peppery Salad Dressing (PSD) (%)	Spicy Salad Dressing (SSD) (%)
Safflower Oil	37.0	37.0
Water	35.0	35.0
Apple Vinegar (10% acetate)	10.0	10.0
Spice Mixture†	10.0	10.0
Sugar	2.5	2.5
Salt	2.0	2.0
Eggyolk Powder	2.0	2.0
Xantham Gum	0.15	0.15
Milk Thistle Seed Press-cake	2.0	2.0
Potassium Sorbate	0.1	0.1
EDTA	0.1	0.1

†For PSD, a 1:1 mixture of dry chili pepper and pimento; for SSD, a 1:1 mixture of dry mint and thyme.

Measurement of the Physico-Chemical Properties of the Samples

The samples' instrumental color was measured with a Minolta CR-400 Reflectance colorimetry (Osaka, Japan). The values of *L** (brightness), *a** (redness/greenness), and *b** (yellowness/ blueness) were read at multiple sites of each sample and recorded. 1.0 gram of each sample was dissolved in 10 ml of pure water, and the probe of the pH meter (PB-11, Sartorius, Göttingen, Germany) was submerged to read the pH values.

Figure 1. The salad dressing samples prepared (PSD: peppery salad dressing, SSD: spicy salad dressing).

The oil phase of salad dressings was extracted with hexane 3 times (1:10 = salad dressing: hexane, w/w) at room temperature, and the solvent was evaporated (40 °C) in a rotary evaporator (Heidolph Laborota 4001, Merck KGaA, Darmstadt, Germany) under vacuum. Then, the free fatty acidity (FFA) of the oils was measured according to the AOCS method Ca 5a-40 (AOCS, 1998). Similarly, the peroxide value (PV) of the extracted oil was measured by following the AOCS method Cd 8-53 (AOCS, 1998). Another oxidation test, the *p*-anisidine value, was completed according to the AOCS method Cd 18-90 (AOCS, 1998), respectively. To analyze total phenolics, the fat of the dressing was first removed by hexane extraction following the procedure of Challacombe et al. (2012). Then, the total phenolics of the solid polar fraction of fat and solid phase were extracted with water/methanol (60/40, v/v) solvent at 1:5 (w/v) ratio 3 times and collected together. Finally, the total phenolics content of the extract was measured following Chotimarkorn et al. (2008) with the Folin-Ciocalteu assay. Standard curve was prepared with the absorbance readings of known concentration solutions of gallic acid standard, and the results were expressed as gallic acid equivalents (mg GAE/100 g oil).

Thermal Properties of the Samples

The melting and crystallization onset, peak temperatures, and enthalpy values of the two salad dressing samples were assessed with Differential Scanning Calorimetry (DSC, Perkin-Elmer 4000 Series, Goriningen, The Netherlands) following the technique of Yılmaz et al. (2022). The instrument was regularly calibrated with indium and zinc. Around 8-10 mg of salad dressing sample was weighed into the aluminum pan and sealed. The empty pan was the reference. The samples were heated from 20 °C to 110 °C at 10 °C/min rate, and then cooled down to –70 °C at 10 °C/min rate, and kept at that temperature for 3 min for full crystallization. Finally, the samples were heated again to 50 °C by 5 °C/min rate. The Pyris 1 Manager software was used to calculate the thermal parameters.

Fatty Acid, Phytosterol and Tocopherol Composition of the Samples

The oil from the salad dressing samples were first extracted with hexane (1:10, dressing: solvent, g: ml) for 3 times, and collected phase were placed into a rotary evaporator (Heidolph Laborota 4001, Merck KGaA, Darmstadt, Germany), and the solvent was evaporated under vacuum. The AOCS method Ce 2-66 (AOCS, 1998) was applied to the oil to prepare the fatty acid methyl esters. The fatty acid compositions of the samples were then analyzed with an Agilent 7890B gas chromatography-FID (Palo Alto, CA, USA) equipped with an HP 88 capillary column (100 m × 0.25mmID × 0.2 μm film thickness, J&W Scientific Co, CA, USA). The temperature

program was heating at 120 ◦C for 1 min, increasing temperature to 175 ◦C by 10 ◦C/min rate for 10 min, then to 210 ◦C by 5 ◦C/min rate for 5 min, and finally to 230 ◦C by 5 ◦C/min rate for 5 min. The analysis conditions were 1 µl injection volume, 1:50 injector split ratio, hydrogen as carrier gas (40 ml/min flow rate), dry air with 450 ml/min flow rate as detector gas, 250 ◦C inlet temperature, and 280 ◦C detector temperature. The fatty acid identification and quantification were achieved by co-chromatography of FAME mixture standards (37-components, C4- C24, Supelco, Bellefonte, PA, USA). Results were provided as % fatty acid composition.

The phytosterol composition of the extracted oil fraction was determined according to ISO 12228 method (ISO, 1999). First, unsaponifiable matters from the oil samples were separated, and then phytosterol fractions were separated by Thin Layer Chromatography (TLC) following the method. Finally, phytosterol compositions were determined with the Gas Chromatograph-FID (Agilent Technologies 7890B) donated with DB5 capillary column (30 m × 0.25 mm ID × 0.1 µm film thickness, J&W Scientific Co). The temperature program was waiting at 60 ºC for 2 min, heating to 220 ºC by 40 ºC/min rate and waiting for 1 min, heating to 310 ºC by 5 ºC/min rate and waiting at that temperature for 30 min. The conditions of the analysis were 1 µl injection volume, 1:100 split ratio, 0.7 ml/min hydrogen carrier gas flow rate, hydrogen (30 ml/min) and dry air (400 ml/min) as detector gases, 290 ºC inlet temperature, and 300 ºC detector temperature. Phytosterols were identified by comparing with commercial standards, and quantification was achieved by using the peak area of α-cholestanol internal standard.

The technique of Grilo et al. (2014) was followed to measure the tocopherol compositions of the oils extracted from the salad dressings. First, 200 µl of oil sample was diluted to 5 ml with dichloromethane, then the mixture was vortexed for 30 sec and placed into a vial. Tocopherol composition was measured by using an HPLC (Shimadzu Corporation, Japan) equipped with LC-20AT HPLC pump, DGU-20A5R degasser, CTQ-10ASVP column oven, inertsil ODS-3 column (250 mm× 4.6mm× 5 µm, GL Sciences Inc., Japan), and a RF-20A fluorescent detector. The working conditions were 20 µl injection volume, methanol: water (97: 3, v/v) mixture as the mobile phase, isocratic elution with a flow rate of 1.5 ml/min, 30 ºC oven temperature, 290 and 330 nm as the detector wavelengths for excitation and emission, respectively. Commercial standards were used for the identification and quantification of the tocopherols.

Quantitative Descriptive Sensory Analysis of the Samples

To describe the salad dressings, the Quantitative Descriptive Sensory Analysis (QDA) was followed (Meilgaard et al., 1991). There were 12 panelists composed of 7 women and 5 men aged between 22 and 47 years. First, the panel was trained on different days and sittings totaling for 10 h. Under the moderation of the panel leader, the panel has selected, defined and standardized the sensory terms for these samples. The panel defined sensory terms, and their definitions and standards are shown in Table 2. A 10 cm line scale from the left side of minimum intensity with 1 to the right side of maximum intensity with 10 was used. The samples were coded with three-digit numbers and served at room temperature under daylight in glass cups covered with a lid. During the test, the panel was also provided with drinking water, unsalted crackers, and an expectoration cup. The sensory analyses were replicated in different days in randomized order.

Consumer Tests for the Samples

The appearance, smell/aroma, taste/flavor, and general acceptance attributes of the salad dressing samples were assessed with 30 volunteer consumers (26 women, 4 men, 21-34 year old) by using a 5-point hedonic scale (1= Dislike extremely, 5= Like extremely). The samples were coded and served in glass cups covered by lid under daylight at room temperature. Water, unsalted cracker and expectoration cups were provided to consumers besides the sample.

Table 2. The sensory descriptive terms, their definitions and standards used to describe the salad dressing samples

Sensory Term	Definition	Referance
Consistency	The resistance of sample against free flow	Regular mayonnaise
Sweet	Basic taste stimulated by table sugar	5% Sucrose solution
Salty	Basic taste stimulated by kitchen salt	0.3% Salt solution
Sour	Basic taste stimulated by organic acids	Lemon juice
Bitter	Taste on tongue stimulated by caffeine or alkaloids	0.1% Caffeine solution
Spicy	Overall aromas associated with pungent spices	Curry mixture
Vinegary	Aroma notes associated with vinegar	Apple vinegar
Metallic	Aromatic associated with metals, tinny or iron	Metallic coin

Statistical Analysis

In this study, the two types of salad dressings were prepared two times as the two replicates at different times. In each replicate sample, the analyses were completed three times. There was a completely randomized design for the experiments. The data were given as the mean values of six measurements with standard errors of the means. The two salad dressings were compared with Analysis of Variance and Tukey's test at 95% confidence level. The non-parametric sensory data was compared with Kruskal-Wallis test with Minitab 16.1.1 software (Minitab, State College, PA) (Minitab, 2010; Razali et al., 2021).

RESULTS AND DISCUSSIONS

The Physico-Chemical Properties of the Salad Dressings

The measured physico-chemical properties of the prepared salad dressing samples are presented in Table 3. The peppery salad dressing (PSD) had around 2.50% of free fatty acidity (FFA), while it was 2.15% in the spicy salad dressing (SSD) sample. This difference was statistically not significant. Since safflower oil used had 1.10% FFA, this enhanced level must be originating from other oil-containing ingredients (egg yolk and Milk Thistle seed press-cake) used (Table 1). In literature, FFA in salad dressings was reported as 0.8-1.3% (Paraskevopoulou et al., 2007). Turkish Standard for salad dressings (TS 7437) defines 0.3% oleate as max. FFA value. Since in this study, cold-pressed safflower oil was used, and the starting oil had 1.10% of FFA, the TS standard was not matched. Salad dressings are mostly sour products, and this amount of FFA could not create any taste problems. The peroxide values (PV) of samples were significantly different (Table 3, $p \leq 0.05$), and SSD had a higher value (8.40 meq O_2/kg) than PSD (3.72 meq O_2/kg), respectively. The safflower oil used had 10.2 meqO_2/kg oil PV, and the salad dressing had lower values due to a proportional decrease of the oil phase in the recipe formulation. The TS 7437 limits PV to 10 meq g/1000 g oil. Both samples comply with the standard. Similarly, PVs of 9.65 meq O_2/kg (Paraskevopoulou et al., 2007) to 1-13 meq O_2/kg (Let et al., 2007) were reported. Another oil oxidation index, *p*-anisidine value, was also measured. SSD sample had a higher value (Table 3). Since *p*-anisidine value indicates the secondary oxidation level, it could be claimed that the rate of oxidation was slower in the PSD sample due to its composition. The total phenolics content of the samples was also different ($p \leq 0.05$), and SSD sample had higher (129.21 mg GAE/100 g oil) amount than that of the (49.62 mg GAE/100 g oil) PSD sample. It would be due to the phenolic content differences of the added spices. Clearly, there was no linear relationship between total phenolics content and level of oil oxidation. The pH value of the samples was around 4.50-4.78, and not different from each other. The TS 7437 provides pH range of 3.2-4.2 for salad dressings. French salad dressing made with mannoprotein from spent brewer's yeast had around 6.0 pH value and during storage pH was decreased (de Melo et al., 2015).

Table 3. The physico-chemical properties of the salad dressing samples prepared

	Peppery Salad Dressing (PSD)	Spicy Salad Dressing (SSD)
Free Fatty Acidity (% linoleate)	2.50 ± 0.00[a†]	2.15 ± 0.02[a]
Peroxide Value (meq O_2/kg oil)	3.72 ± 0.55[b]	8.40 ± 1.15[a]
p-Anisidine Value	3.48± 0.46[b]	4.27 ± 0.54[a]
Total Phenolics (mg GAE/100 g oil)	49.62 ± 0.12[b]	129.21 ± 0.11[a]
pH Value	4.50±0.01[a]	4.78 ± 0.07[a]
Color *L** Value	40.56 ± 0.10[b]	42.58 ± 0.17[a]
Color *a** Value	9.42 ± 0.35[a]	-1.26 ± 0.01[b]
Color *b** Value	20.41 ± 0.90[a]	14.86 ± 0.01[b]

†Small letters in the same row indicate the significant differences between the samples ($p \leq 0.05$; $n = 6$).

The color values of the samples had significant differences ($p \leq 0.05$, Table 3). Both samples can be observed from Fig. 1. Since the added spices and their natural colors were different, the measured color differences are quite expected. The SSD sample was brighter (42.58 *L** value). Both samples had certain level of brightness, most possibly due to the light reflecting effect of the oil phase. The *a** value indicates the level of redness (+ *a** values) and greenness (- *a** values). Clearly, SSD had green color while PSD was a red sample (Fig. 1). The added paprika pepper provided the red color, and the added green leafy mint and thyme spices yielded the green color, expectedly. Similarly, the *b** value indicates yellowness/blueness on positive/negative number directions (Pomeranz and Meloan, 1991), and both samples had some yellowness, but it was higher in the PSD sample, respectively. Due to the color pigments present in the added spices, these color differences have occurred. In literature, quite diverse color values depending on the ingredients used were reported (Ma et al., 2013; de Melo et al., 2015; Manshadi et al., 2019).

Thermal Properties of the Salad Dressings

DSC-determined thermal properties of the salad dressing samples are summarized in Table 4. There were some differences between the samples. The fully crystallized SSD sample had a peak melting temperature of –18.68 °C, and the same was –14.11 °C for PSD sample. Similarly, the crystallization peak temperatures were –30.52 °C and –26.06 °C for SSD and PSD samples, respectively. Clearly, the SSD sample was more liquid at lower temperatures. Since both samples had the identical product formulation, except for the added spices, these thermal behavior differences could be attributed to the added spices. This effect could be due to the oils and essential oils infiltrating from the added spices into the dressing, or it could be a physical effect of spice particulates on the fat crystallization of the safflower oil. For any fat product, the thermal behavior is of course, defined by the fatty acid composition of the oily phase. Since safflower oil is unsaturated, the measured data seems quite proper and expected. Practically, these salad dressings were liquid at refrigerator or even lower temperatures. For any pourable type of salad dressing, it would be better if the sample flowed freely after taking it from the refrigerator. The prepared samples showed acceptable thermal properties as salad dressing samples. No similar data found in the literature.

The Fatty Acid, Phytosterol and Tocopherol Compositions of the Salad Dressings

The compositions of fatty acids, phytosterols and tocopherols measured in the salad dressing samples are presented in Table 5. Eight different fatty acids were quantified in both samples. Linoleic acid was the predominant one (77.50% and 78.00%) in both samples, followed by oleic acid (13.58% and 12.98%) and palmitic acid (5.75% and 5.85%) for PSD and SSD samples,

respectively. Myristic, linolenic, arashidic and gadoleic acids were quantified under 1% levels. There was a statistically significant difference only in the oleic acid content for the samples, and the rest were not significantly different ($p \geq 0.05$, Table 5). Both samples contained more than 90% of unsaturated fatty acids, including the essential (linoleic and linolenic) fatty acids. In one of our previous studies (Aydeniz et al., 2014), cold-press-produced safflower oil was analyzed for its fatty acids, and as main components, 75.50-77.43% linoleic acid, 12.29-14.79% oleic acid, and 6.69-6.79% palmitic acids were quantified. Clearly, prepared salad dressing samples had quite similar fatty acid compositions, respectively. Other oil-containing ingredients (egg yolk powder and Milk Thistle seed press-cake) were added at only 2% level, and had not created a big difference in fatty acid composition.

Table 4. The thermal properties of the salad dressing samples prepared

		Peppery Salad Dressing (PSD)	Spicy Salad Dressing (SSD)
Melting	$Onset_m$ (°C)	-25.56 ± 1.08[a†]	-29.9 ± 1.28[b]
	T_m (°C)	-14.11 ± 1.1[a]	-18.68 ± 3.95[b]
	ΔH_m (J/g)	29.96 ± 2.43[a]	4.14 ± 2.18[b]
Crystallization	$Onset_c$ (°C)	-26.14 ± 0.85[a]	-29.74 ± 2.09[b]
	T_c (°C)	-26.06 ± 0.91[a]	-30.52 ± 2.55[b]
	ΔH_c (J/g)	-30.17 ± 2.68[b]	-4.6 ± 1.12[a]

†Small letters in the same row indicate the significant differences between the samples ($p \leq 0.05$; $n = 6$).

Table 5. The fatty acid (%), phytosterol (mg/kg oil) and tocopherol (mg/kg oil) compositions of the salad dressing samples prepared

	Peppery Salad Dressing (PSD)	Spicy Salad Dressing (SSD)
Myristic acid (C14:0)	0.25 ± 0.03[a†]	0.25 ± 0.01[a]
Palmitic acid (C16:0)	5.75 ± 0.63[a]	5.85 ± 0.50[a]
Stearic acid (C18:0)	2.55 ± 0.37[a]	2.50 ± 0.45[a]
Oleic acid (C18:1)	13.58 ± 0.33[a]	12.98 ± 0.03[b]
Linoleic acid (C18:2)	77.50 ± 3.45[b]	78.00 ± 2.15[a]
Linolenic acid (C18:3)	0.50 ± 0.01[a]	0.50 ± 0.01[a]
Arashidic acid (C20:0)	0.20 ± 0.01[a]	0.20 ± 0.01[a]
Gadoleic acid (C20:1)	0.15 ± 0.01[a]	0.15 ± 0.01[a]
∑ Saturated	8.75	8.80
∑ Unsaturated	91.73	91.63
β-Sitosterol	915.52 ± 84.37[a]	913.48 ± 81.69[a]
Stigmasterol	138.22 ± 10.98[a]	139.82 ± 11.50[a]
Campesterol	245.18 ± 31.42[a]	241.63 ± 32.71[a]
Δ-7-Stigmastenol	357.26 ± 42.39[a]	354.37 ± 41.83[a]
Δ-7-Avenasterol	44.29 ± 6.37[a]	43.77 ± 5.46[a]
∑ Sterol	1700.47	1693.07
δ-Tocopherol	30.95± 4.03[a]	32.15 ± 3.89[a]
β- Tocopherol	139.5 ± 7.74[a]	138.61 ± 6.52[a]
γ- Tocopherol	114.22 ± 5.51[a]	113.58 ± 4.69[a]
∑ Tocopherol	284.67	284.34

†Small letters in the same row indicate the significant differences between the samples ($p \leq 0.05$; $n = 6$).

Five phytosterols were quantified in the samples, with around 915 mg/kg of β-sitosterol as the major one. From higher to lower amounts, β-sitosterol, Δ-7-stigmasterol, campesterol, stigmasterol, and Δ-7-avenasterol were quantified. There was no significant difference between the two samples (Table 5). Both samples had around 1700 mg/kg total phytosterols. The phytosterol composition reported by Aydeniz et al. (2014) was similar to these samples. These salad dressing samples could be accounted as good sources of phytosterols, as long as phytosterol compositions of the common cold-pressed vegetable oils are considered (TGK, 2012). The positive health effects of phytosterols could be affirmed in any of the main lipid sources (Aydeniz et al., 2014).

Only three tocopherols (δ-, β- and γ-) were quantified in the samples, with β-tocopherol as the dominant (138-139 mg/kg) one (Table 5). Total tocopherol contents were not different for the PSD and SSD samples. Aydeniz et al. (2014) reported around 1600-2000 mg/kg of α-tocopherol in a cold-pressed safflower sample, and it was quite different from the findings of this study. This could be attributed to sampling and analysis technique differences.

Overall, the prepared salad dressings were determined to be good sources of nutrient components and would provide quite high quantities of essential fatty acids, phytosterols, and some tocopherols.

Sensory Descriptive Analysis Results of the Salad Dressings

The prepared fresh salad dressing samples were evaluated by 12 trained sensory panelists by using 8 descriptive terms (Table 6). 'Consistency' was defined as the resistance of salad dressings against the free flow. Both samples had around 8.5-9.5 scores compared with 10 score of mayonnaise samples. Consequently, the samples were not like free-flowing liquids but more like mobile gels, expectedly. This score also indicates the pourability of the dressings. As the main taste, both samples had some 'sweet' values. The product formulations (Table 1) included 2.5% of sugar, but since the sample included aromatic spices and vinegar, the sweetness perception was reduced, respectively. The panel defined some 'salty' taste, and it would originate from table salt and other ingredients used in product formulations. 'Sour' scores of the samples were similar (2.8), and would be related to the acetic acid present in the vinegar used. There was a significant difference between the samples for 'bitter' scores. The PSD sample had significantly higher bitter values (8.9) than that of the SSD sample (1.25). This is quite an expected finding since the PSD sample had dry chili pepper in the formulation (Table 1). In fact, this was the type of sample which must have a perceptible bitter taste. For the 'spicy' scores, the PSD sample had higher (7.2) than the SSD sample (6.5), and this also would be possible due to the chili pepper and pimento yielding a more spicy sensation than dry mint and thyme mixture used in the other sample. The 'vinegary' scores were moderate and not different between the samples. Finally, both samples had some 'metallic' sensations, possibly caused by the oil oxidation or ingredient interactions.

Table 6. The quantitative sensory descriptive analysis (QDA) results of the salad dressing samples prepared

	Peppery Salad Dressing (PSD)	Spicy Salad Dressing (SSD)
Consistency	$8.5 \pm 1.5^{a\dagger}$	9.5 ± 0.7^{a}
Sweet	1.6 ± 0.1^{a}	1.5 ± 0.8^{a}
Salty	4.7 ± 1.4^{a}	4.2 ± 1.4^{a}
Sour	2.8 ± 0.8^{a}	2.8 ± 0.9^{a}
Bitter	8.9 ± 1.4^{a}	1.25 ± 1.6^{b}
Spicy	7.2 ± 1.5^{a}	6.5 ± 2.3^{a}
Vinegary	3.7 ± 2.8^{a}	2.4 ± 2.6^{a}
Metallic	1.2 ± 0.9^{b}	2.1 ± 0.9^{b}

†Small letters in the same row indicate the significant differences between the samples ($p \leq 0.05$; $n = 6$).

In a study (Ma et al., 2013), lentil flour-enriched canola oil salad dressings were evaluated by a QDA panel with 5 terms (legume flavor, vinegar, acidity, grittiness, firmness and overall flavor attribute). Since we prepared pourable samples,

our panel described sample texture with consistency terms. Further, sour and vinegar were common descriptors. In another study (Sainsbury et al., 2016), sunflower oil salad dressings were described with 14 different sensory terms (pungent, vinegar, eggy, citrus, musty, dairy, green, oil, earthy, metallic, plastic, cardboard, painty and rancid). Clearly, different panels could use a diverse number of descriptors based on primary oil, and ingredient differences. Basically, product formulation ratios, the aroma/flavor potency of the ingredients used, and preparation techniques could differentiate the sensory attributes of the salad dressings. Although egg yolk powder is included in our samples, the panel has not used any terms related to eggs in our samples, possibly due to the concentrated spices and their intense aromas. Finally, Manshadi et al. (2019) used sensory QDA to test their samples with taste, viscosity, color, texture, and overall acceptability terms. The panel differences and goal of each test could cause diverse sensory terms usage, expectedly. Overall, samples prepared in this study seem pourable but consistent, very spicy and bitter, vinegary salad dressings. Any sensory test completed with a consumer test would be more informative about the market success of food products. Hence, a consumer test was also completed for these samples.

Consumer Test Results of the Salad Dressings

A hedonic test was completed with 30 volunteer consumers, and the results are summarized in Table 7. Except for appearance, there was no significant difference between PSD and SSD samples for smell/aroma, taste/flavor, and general acceptance scores. The appearance of PSD had a higher score. Generally, both samples had scores above 3.0 points (the neutrality point; neither like-nor dislike) for appearance and smell/aroma but lower scores for taste/flavor and general acceptance. Clearly, some modifications to improve the taste/flavor of the prepared salad dressings are needed to enhance their consumer acceptance. Ratio of the ingredients, and especially the kind and amounts of the spices used, could be changed to get a better taste/flavor and acceptance. Consequently, more research is needed. French salad dressing made with mannoprotein from spent brewer's yeast was evaluated with 60 untrained consumers (de Melo et al., 2015). Flavor, color, taste, texture, overall acceptance, and purchase intention indicated some differences among the samples, usually some decreases after the storage period. There are not many similar studies with consumers in the literature; hence, our results contribute comparable data for upcoming studies.

Table 7. The consumer test results of the salad dressing samples prepared

	Peppery Salad Dressing (PSD)	Spicy Salad Dressing (SSD)
Appearance	$3.40 \pm 1.03^{a\dagger}$	2.73 ± 1.14^{b}
Smell/Aroma	3.43 ± 0.97^{a}	3.26 ± 1.58^{a}
Taste/Flavor	2.53 ± 1.07^{a}	2.45 ± 1.33^{a}
General Acceptance	2.90 ± 0.99^{a}	2.85 ± 1.10^{a}

†Small letters in the same row indicate the significant differences between the samples ($p \leq 0.05$; $n = 6$).

CONCLUSIONS

In this study, two different salad dressings were prepared and evaluated. Cold-pressed safflower seed oil and Milk Thistle seed press-cake were used as the functional ingredients. The dressings were prepared according to TS 7437 Turkish salad dressings standard. FFA and PV of the samples were within the acceptable limits of the vegetable oils codex. The pH values were in accordance with the salad dressing standard. The total phenolic content of SSD sample was significantly higher, and both samples showed color values resembling the added spice colors (red pepper and green spices). The dressings had full crystallization temperatures at around –26 to –30 ^{o}C, and melting peaks at around –14 to –19 ^{o}C, respectively. They were fairly liquid at refrigerator temperatures. Both dressings were found to be good sources of unsaturated and essential fatty acids. Further, they included fairly good amounts of total sterols, with the majority occurring as β-sitosterol. Also, the samples were good sources of

tocopherols. These nutritional sources would make them functional preparations. Sensory descriptive analysis (QDA) was completed with a trained panel and 8 descriptive terms. The samples were mainly described as bitter and/or spicy, vinegary, and salty dressings. The panel has not detected any egg-related sensory descriptor. The samples were found to be consistent but pourable. Lastly, consumer tests indicated that the taste/flavor of the samples must be enhanced to increase their general acceptance. Consequently, modifications of the kinds and ratios of the ingredients used, especially the spices used, are suggested as new research needs. Overall, nutritionally enhanced and enriched new salad dressing formulas based on cold-pressed oils and press-cakes could be developed to offer consumers new functional foods.

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AUTHOR CONTRIBUTIONS

Manuscript writing: Emin Yılmaz, planning the experiments: Emin Yılmaz and Emine Bildi, laboratory experiments: Emine Bildi and Emin Yılmaz, the idea of the study: Emin Yılmaz, designing the study: Emin Yılmaz, editing original draft: Emin Yılmaz. All authors have read and approved the final manuscript.

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