



Preparation and physicochemical analysis of a traditional beverage based on *D. Sophia*

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ABSTRACT

Background & Aim: The main aim of this study was stabilizing *D. Sophia* beverage and reduce its sedimentation rate.

Experimental: Xanthan and Carboxy methyl cellulose gums have been used in three levels (0.05, .1 and .2 gr/lit) and mixture of Guar-xanthan and carboxymethyl cellulose (each .1 g/l) and extracted dried gum from *D. Sophia* in (1, 2 and 4 g/l) levels were added to beverage. Physicochemical, microbial and sensorial tests have been applied.

Results: Results indicated that pH, acidity, color and turbidity have been changed by gum addition while sedimentation rate has been reduced that resulted more stable beverage. The relationship between sedimentation rate and viscosity also has been investigated which showed other factors more than viscosity were effective in sedimentation rate. Increasing absorption of matrix during the time showed that dissolved material has been increased over the time. Microbial analysis showed increment during storage. Sensory evaluation indicated that commercial gums have no significant effect on acceptability of beverages while *D. Sophia*'s gum has undesirable effect on it.

Recommended applications/industries: According to the obtained data, it was determined that mixture of xanthan – guar gum and xanthan gum in 0.05g/l level had the best effect on the *D. sophia* particles stabilization.

1. Introduction

D. sophia, is an annual or biennial herb in the *Cruciferae* family and a member of the *Brassicaceae* family which goes by scientific names *Descurainiasophia* L. and *Sisymbriumsophia* L. Its beverage is one of the Iranian traditional beverages which have many uses in traditional medicine (Al-Jaber, 2011). The most important compound of the *D. sophia*

seeds contains glucosinolates which include allyl isothiocyanate, butylnisothiocyanate, cyano 3 and 4-epithiobutan, 5-methylthiopentanenitrile, 3-phenylpropionitrile, 4-methylthio butyl isothiocyanate, and 2-phenylethyl isothiocyanate. Other compounds include palmitic fatty acid, linolenic acids, oleic acids, and stearic acids. The mineral compounds in the seed include sulfur, chlorine, phosphorus, iron, potassium, calcium, sodium, and magnesium. The seed also

contains protein, gum, mucilage, fat, and nitrogen compounds (Abedinirad *et al.*, 2012).

In today's world usage of the food sources is one the concerns of mankind and mankind is looking for developing natural resources which is always one of the important aspects of the study. In this study we are looking for a way to stabilize the *D. sophia* beverage for commercial production. Among the science of the beverages in traditional medicinal herbs like *D. sophia* have many applications because of their useful properties. *D. sophia* in the traditional medicine, is a warm nature herb (has a warm humor) possessing so many properties such as healing wounds and injuries, antipyretic, diarrhea treatment, antihelminthic and treatment of kidney stones, treatment of deficiency of vitamin C, and disinfection properties. However, as we know, despite having so many useful properties and high nutrition, this beverage often due to lack of industrial production hasn't been in the interest of the food industry so far, and it seems that one of the main problems to do so is instability of the beverage after production (Al-Jaber, 2011; Abedinirad *et al.*, 2012; Khan and Wang, 2012)

Despite high molecular weight xanthan gum dissolves readily in cold and warm water and even in very small amounts produces high concentrated solutions and pH changes doesn't have much effect on it. The main use of xanthan is as a thickener, stabilizer, and viscosity modifier agent and in integrating powder mixtures and in stabilizing the emulsion (MohammadiHashemi, 2011; Whistler and Bemiller, 1992) In addition to thickening, adhesion, and developing stability, Carboxy Methyl Cellulose or CMC is also diffusion agent, water maintenance agent, colloidal state maintainer, stabilizer, suspending agent, emulsifier, and layer construction agent. This substance dissolves readily in cold and warm water and is used basically in circumstances where viscosity control is important. The fact that this substance is a viscosity control agent has made it to be able to be used as a thickener, stabilizer, emulsifier (like casein) and suspending agent. Guar gum in low concentrations produces viscous solutions and its 2-3% concentration produces gel. This gum doesn't show any incompatibility to proteins or other polysaccharides.

Facility of the guar use in the industry, due to its diffusion and rapid hydration in cold and warm waters, as well as usage of the substance to obtain proper concentrations and sometimes increase in water absorption in the products etc. According to widespread use of this substance in wide range of emulsifiers, softeners, and stabilizers (Whistler and Bemiller, 1992). In elder researches, they reach to the conclusion that native gums, in the presence of iron ions, can stabilize as well as enrich the Flixweed beverage where its sensory characteristics was very similar to the unstable regular beverage. Based on the findings of another study, water-soluble fractions of gum tragacanth and Persian gum can be categorized as anionic hydrocolloids which are adsorbed on the surface of caseins which can prevent aggregation via steric and electrostatic repulsions by simulating a hairy layer. In addition, their insoluble fractions could promote physical stability of the mixtures due to making a gel-like network and increasing viscosity.

2. Materials and Methods

D. sophia seeds were obtained from the local market, Shiraz, Iran and they had been purchased from Birjand, Iran. Xanthan, CarboxyMethylCellulose (CMC) and guar gums from Merck Company (Darmstadt, Germany), were prepared from research center of Isfahan University of technology as powder and *D. sophia* gum had been extracted in the way which will be explained later. Citric acid and lemon essence prepared from Shiraz Zamzam factory. QLab's growth medium plate count agar was used for microbial evaluation.

In this research, *D. sophia* gum, xanthan, CMC and guar gums in different concentrations were used to keep *D. sophia* beverage stable and prevent sedimentation of its seeds. Physicochemical, microbial (first and end of the two months storage), sensory (for both two formulation type) evaluations were done. Physicochemical evaluations include pH, acidity, color, turbidity, particle size, sedimentation rate (for both formulation types), and spectrophotometric (absorption and FT-IR) measuring to obtain beverage solution's color and *D. sophia* gum's chemical structure. Other

than the mentioned above, other evaluations were done for the formulation 2.

D. sophia beverage preparation method

For this purpose 15g *D. sophia* and 25g sugar were used in 250 ml of water. Therefore the above mentioned quantities can be expressed in percentages, too (Table 1).

D. sophia gum preparation and extraction method

D. sophia, rinsed and warmed to 45-50 °C in water bath and after cooling, it was kept in the refrigerator for 3-5 days.

The *D. sophia* then was filtered with cloth or screen. After rotating, the obtained extract was poured on a plain surface like tray and kept in an oven at 60-70 °C to dry. The dried gum was then cut off from the tray by spatula.

Analysis of physicochemical composition

Spectrophotometric evaluation

Determination of maximum Absorption frequency (λ_{max})

Samples were poured into quartz cell and their absorption 300-500 nm wavelengths were read by spectrophotometer (Kontron's Bio TekUviKon 923, England). Each samples absorbance was calculated considering the wavelengths which had maximum absorption and then this amount was decreasing (Skoog and West, 1997)

The maximum absorption frequency has been calculated according to Skoog's principles of instrumental analysis book and this wavelength which was equal to 320 nm was set on (Sherwood 320, England) spectrophotometer for subsequent spectrophotometric evaluations and all the samples absorption were read once every 2 weeks for 2 months with 10 times dilution.

Fourier Transform InfraRed (FT-IR)

FT-IR spectrum of purified gum was obtained in order to identify bonds and chemical structures. The equipment also has the ability to identify surface bonding. In this method, light is radiated to the sample's surface and the percentage of the light transmission or

light absorption will be measured by the equipment, and bond types and material structure will be determined through existing sources. The sample was incorporated into KBr (spectroscopic grade) and pressed into a 2 mm pellet. IR spectra were recorded in the transmittance mode from 4000 to 450 cm^{-1} . For this purpose we used absorption spectrometry (Perkin Elmer Atomic, US) (Paradkar and Irudayaraj, 2002; Farahnaky and Askari, 2010).

Measuring color indicators

Color properties of the prepared *D. sophia* beverages were assessed by Colorflex EZ (Hunterlab, Virginia, USA), SI (saturation index) (Eq1), hue angle (Eq2), ΔE (total color difference) (Eq3), a^* (+, red; -, green), L^* (Lightness index) and b^* (+, yellow; -, blue) indicators were defined (Behbahani and Abbasi, 2014; Saricoban and Yilmaz, 2010).

$$SI = \sqrt{a^{*2} + b^{*2}} \quad (1)$$

$$H = \arctan(b^*/a^*) \quad (2)$$

$$\Delta E = \sqrt{(L_0 - L^*)^2 + (a_0 - a^*)^2 + (b_0 - b^*)^2} \quad (3)$$

Turbidity measurement

It was measured by turbidity meter device based on FTU (HI 98703 HANNA, US) (Muthuraman and Sasikala, 2012).

pH evaluation

By using pH meter (Metrohm, 827 device, Switzerland), after calibration with buffer solution 7 and 4, device's electrode was put in the sample, and the digit was written after it was fixed (Sedaghat and Hosseini, 2011). This evaluation was done once every 2 weeks for 2 months and for both formulations.

Acidity evaluation by titration method

In this evaluation, fresh 0.1 N solution was prepared and then 25 cc of the sample was titrated with it and 3 droplets of phenolphthalein indicator were used till it turned into purple, then the amount of sodium usage was read, put into acidity equation in citric acid and the acidity was gained in Dornic degree by equation 4 (Sedaghat and Hosseini, 2011).

$$\text{Acidity} = \frac{a * 0.0064 * 100 * 100}{10 * S}$$

Where:

(4)

a – volume of the sodium usage

S – 25 ml (volume of the sample)

0.0064 – one ml $\frac{N}{10}$ sodium is equal to 0.0064g citric acid

Stabilization of D. sophia in beverage by gums

Formulation 1

15g of *D. sophia* was rinsed, reached to 250 cc volume and 25g of sugar was added to it. It was heated to 40 °C by a hot plate magnet (thermal magnetic stirrer) and then the gums were added after reaching this temperature and the stirring was continued until 50 °C and complete dissolution of the gums (Table 2).

Formulation 2

15g of *D. sophia* was rinsed, reached to 250 cc volume and 25g of sugar was added to it. It was heated to 40 °C by a hot plate magnet (thermal magnetic stirrer) and then the gums were added after reaching this temperature and the stirring was continued until 50 °C and complete dissolution of the gums. 0.1% citric acid (according to number 2837 standard) and then 0.05% lemon essence (FCC fifth edition 2014) was added to it. The made solution was poured into a lidded glass and was put in water bath (75 °C, 15 s) for pasteurization (FDA), and after cooling down was kept in the refrigerator at 4 °C.

In order to keep samples in the refrigerator for 2 months, the pasteurization was done and citric acid was used to reduce acidity in order to reduce microbial growth and lemon essence was used to flavor the beverage and masking the acidic flavor (Table 2).

Particle size evaluation

This evaluation was conducted by optical digital camera with 2.5 zoom. For this purpose, some of each sample was poured into a plate and put in a container and was photographed by the camera. The surface, maximum, minimum, and average particles' diameter,

and their sphericity were then achieved by image processing program.

Sedimentation rate evaluation

In this evaluation samples were put into measure and the sedimentation time to half measure volume was practically measured by chronometer. The sedimentation rate (V) was also theoretically calculated by Stokes' law and finally the theoretical and practical value were compared (Foroughinia *et al.*, 2009).

The complete description of Stokes' law (eq.5) shows us that a particle's speed settling into a fluid is directly related to gravity (g), the difference between particles' and water density (D₁-D₂), and the square of the particle's radius. The sedimentation rate is inversely related to fluid's viscosity or thickness or liquid's viscosity (η).

$$V_1 = \frac{2gr^2(D_1 - D_2)}{\eta} \quad (5)$$

Where:

V: sedimentation rate in centimeter per second

g: gravity acceleration, which is considered equal to 980 cm per square second.

r: radius of the particle settling in the liquid in cm.

D₁: actual weight, which is considered in g/cm³.

D₂: water density, which is equal to one g/cm³.

η: liquid's viscosity which is considered equal to 1cP(0.01 g/cm.sec) for water.

Due to importance of the radius in this equation particle size effect on sedimentation rate will be discussed as follows.

Microbial evaluation

In order to identify primary sample and product's microbes after 2 months storage in the refrigerator, total count evaluation was done with plate count agar (PCA) culture medium (QLab's) in 10⁻¹, 10⁻², and 10⁻³ dilutions and in duplicate (Iranian National Standardization Organization).

Evaluation of some sensory properties

Some of sensory properties of the samples (taste, appearance, mouth feel, color, and the general admission) in 6-point Hedonic evaluation framework was evaluated as very high utility, high utility, low

utility, low disutility, high disutility, and very high disutility by 30 trained panelists. The taste evaluation results also showed that the average points of the stabilized systems by different parts of the xanthan and CMC gums weren't so different from the control sample (*D. sophia* beverage without gum), even in some cases the panelists evaluated them more desirable (Behbahani and Abbasi, 2014).

3. Results and discussion

Spectrophotometric evaluations

All the samples with wavelengths between 314-324 nm had the maximum absorption value and according to the graphs obtained from the device the 320 nm wave which was on top of the graphs was considered the λ_{max} .

By using gained absorptions during 2 months, it was deduced that the absorption value increases in time and also it was in its maximum at the last (fourth) week and in some gums like *D. sophia* due to being chromatic, had an extent increase at the end of the fourth week. This increase in absorption is because more substance has been dissolved in the solution and the chromatic substances due to gums were permeated into the solution (Skoog and West, 1997).

Colorimetric measurement

Control treatment had more transparency and clarity and gums reduced *D. sophia* beverage's transparency. *D. sophia* and xanthan gums had the most influence on the transparency reduction and CMC gum had the least influence in this matter which in fact was predictable given the CMC gum and xanthan properties and *D. sophia* gum color. Unlike results obtained from Behbahani and Abbasi (1393) study which L^* index was between 27-32, L^* index obtained from the tests were variable in 50-90 range which implies samples more transparency in compare to that study. In fact the L^* value obtained from the last study showed a lot of turbidity in the beverage.

According to the a^* index, b^* and c^* index was also deduced that control treatment and CMC had the least value and in *D. sophia* and xanthan gum treatment had the most value due to the mentioned reasons

(Behbahani and Abbasi, 2014; Saricoban and Yilmaz, 2010).

As it is determined with other index treatments total color difference was minimum in the control treatment due to the lack of gum and this difference is greater in the treatments with more turbidity than the control treatment such as treatments containing *D. sophia* and xanthan gum.

According to the above results the hue angle index also had the maximum value in control treatment and treatments containing CMC and had less value in *D. sophia* and xanthan gum.

Turbidimetric evaluation

As it was resulted from turbidimetric evaluation, control treatment had the minimum turbidity and treatments containing *D. sophia* gum had the maximum turbidity due to the gum color and having colloidal substances and in all the samples turbidity increased with gum concentration increase, which was predictable (Table 3).

pH evaluation

Time didn't have significant effect on pH, it means that hydrogen ion concentration didn't change and pH was kept in the acidic range. This pH range is justifiable according to the beverages standard (Iranian National Standardization Organization, 2010).

Acidity evaluation

Given the acidity evaluation it is deduced that acidity changes during 2 months was about $0.2^\circ D$ and the amount of the consumed NaOH had very little change, too (Iranian National Standardization Organization, 2010).

In fact pH and acidity results show that these two factors acted coordinately and had no effect on the consumed gums and also the refrigerator temperature kept these two factor in a certain range. Changes in acidity have been expressed in table 4.

Table 1. Number, name, and constituent components of the samples

Numbers	Names & constituent	Symbols	Symbols in figs	Percentage of components
1	Xanthan gum 0.0125 g	Xan 0.0125	X0.0125	0.005%
2	Xanthan gum 0.025 g	Xan 0.025	X0.025	0.01%
3	Xanthan gum 0.05 g	Xan 0.05	X0.5	0.02%
4	Carboxy Methyl Cellulose 0.0125 g	CMC 0.0125	C0.0125	0.005%
5	Carboxy Methyl Cellulose 0.025 g	CMC 0.025	C0.025	0.01%
6	Carboxy Methyl Cellulose 0.05 g	CMC 0.05	C0.05	0.02%
7	Xanthan 0.025 g+ Guar 0.025 g	Xan + Gu	X+G	0.01%
8	Xanthan 0.025 g+ Carboxy Methyl Cellulose 0.025 g	Xan + CMC	X+C	0.01%
9	Blank	Blank	Blank	0%
10	<i>D. sophia</i> gum 0.25 g	Self 0.25	S0.25	0.1%
11	<i>D. sophia</i> gum 0.5 g	Self 0.5	S0.5	0.2%
12	<i>D. sophia</i> gum 1 g	Self 1	S1	0.4%

Table 2. Formulations and differences

Formulations			Differences				
1	15g of <i>D.sophia</i>	250cc water	25g of sugar	gums	-----	-----	-----
2	15g of <i>D. sophia</i>	25cc water	25g of sugar	gums	0.1% citric acid	0.05% lemon essential oil	pasteurization

Table 3. Comparing turbidimetric and colorimetric evaluations average

Samples	L*	a*	b*	C*	ΔE	SI	Turbidity (FTU)
1	<i>f</i> 76.02 ± 0.07	<i>c</i> 1.98 ± 0.01	<i>e</i> 13.86 ± 0.05	<i>e</i> 13.99 ± 0.05	<i>f</i> 19.65 ± 0.05	<i>g</i> 82.23 ± 0.03	<i>c</i> 14.72 ± 0.09
2	<i>i</i> 61.76 ± 0.43	<i>b</i> 3.98 ± 0.04	<i>b</i> 17.33 ± 0.18	<i>b</i> 17.78 ± 0.16	<i>c</i> 34.28 ± 0.35	<i>i</i> 77.06 ± 0.26	<i>c</i> 20.12 ± 1.63
3	<i>j</i> 52.98 ± 0.02	<i>a</i> 4.72 ± 0.03	<i>c</i> 16.60 ± 0.05	<i>c</i> 17.25 ± 0.06	<i>b</i> 42.24 ± 0.00	<i>j</i> 74.13 ± 0.05	<i>c</i> 39.77 ± 1.11
4	<i>d</i> 86.71 ± 0.50	<i>f</i> 0.42 ± 0.09	<i>g</i> 9.65 ± 0.11	<i>g</i> 9.66 ± 0.11	<i>h</i> 8.16 ± 0.37	<i>d</i> 87.53 ± 0.57	<i>c</i> 9.69 ± 0.12

5	<i>c</i> 89.47 ± 0.01	<i>h</i> -0.21 ± 0.00	<i>j</i> 5.82 ± 0.02	<i>j</i> 5.82 ± 0.02	<i>i</i> 4.10 ± 0.01	<i>b</i> 92.01 ± 0.04	<i>c</i> 6.35 ± 0.37
6	<i>e</i> 84.15 ± 0.12	<i>j</i> -0.52 ± 0.10	<i>k</i> 5.25 ± 0.10	<i>k</i> 5.27 ± 0.10	<i>g</i> 9.37 ± 0.11	<i>a</i> 95.59 ± 0.93	<i>c</i> 9.83 ± 0.19
7	<i>c</i> 89.30 ± 0.09	<i>g</i> -0.10 ± 0.01	<i>i</i> 6.08 ± 0.02	<i>i</i> 6.08 ± 0.02	<i>i</i> 4.32 ± 0.09	<i>c</i> 90.90 ± 0.06	<i>c</i> 16.82 ± 1.10
8	<i>b</i> 91.88 ± 0.05	<i>i</i> -0.31 ± 0.08	<i>h</i> 6.91 ± 0.06	<i>h</i> 6.92 ± 0.06	<i>j</i> 2.34 ± 0.07	<i>b</i> 92.56 ± 0.64	<i>c</i> 14.51 ± 0.86
9	<i>a</i> 93.52 ± 0.43	<i>j</i> -0.52 ± 0.10	<i>k</i> 5.25 ± 0.10	<i>k</i> 5.27 ± 0.10	<i>k</i> 0.30 ± 0.26	<i>a</i> 95.59 ± 0.93	<i>c</i> 6.96 ± 0.35
10	<i>k</i> 40.90 ± 0.03	<i>b</i> 4.04 ± 0.00	<i>a</i> 22.79 ± 0.04	<i>a</i> 23.14 ± 0.03	<i>a</i> 55.65 ± 0.02	<i>h</i> 79.95 ± 0.02	<i>c</i> 38.58 ± 4.22
11	<i>g</i> 69.67 ± 0.14	<i>e</i> 1.20 ± 0.01	<i>f</i> 12.15 ± 0.09	<i>f</i> 12.20 ± 0.09	<i>e</i> 24.88 ± 0.11	<i>f</i> 84.36 ± 0.09	<i>b</i> 164.67 ± 66.23
12	<i>h</i> 69.26 ± 0.05	<i>d</i> 1.33 ± 0.09	<i>d</i> 15.94 ± 0.10	<i>d</i> 15.99 ± 0.10	<i>d</i> 26.57 ± 0.09	<i>e</i> 85.24 ± 0.29	<i>a</i> 265.00 ± 56.67

Means (± standard deviation) with small common letters doesn't have significant differences at 5% level in Duncan.

Table 4. Acidity changes in D. Sophia beverage during the storage

Treatment	First week	Second week	Third week	Forth week
1	0.793	0.870	0.742	0.896
2	0.870	0.870	0.742	0.896
3	0.870	0.870	0.716	0.870
4	0.819	0.844	0.691	0.844
5	0.819	0.844	0.691	0.870
6	0.819	0.844	0.742	0.819
7	0.819	0.819	0.742	0.870
8	0.819	0.844	0.768	0.896
9	0.793	0.768	0.716	0.844
10	0.844	0.844	0.742	0.870
11	0.768	0.844	0.768	0.793
12	0.742	0.742	0.742	0.819

Table 5. Theoretical and practical sedimentation rate comparison in both formulations

Samples	Formulation 1			Formulation 2		
	Theoretical	Practical	Theoretical & practical ratio	Theoretical	practical	Theoretical & practical ratio
Xan 0.0125	1.5	1.16	0.77	1	1.29	1.28
Xan 0.025	1.47	2.48	1.68	1.3	2.02	1.54
Xan 0.05	2.41	4.52	1.87	2.43	5.7	2.33
CMC 0.0125	1.16	1.53	1.3	1.26	1.51	1.19
CMC 0.025	1.31	1.52	1.15	1.11	1.53	1.37
CMC 0.05	1.03	1.28	1.23	1.1	1.21	1.09
Xan + Gu	1.56	34.99	22.32	1.23	37.12	30.14

Xan + CMC	1.56	3.45	2.19	1.32	3.73	2.82
Blank	1	1	1	1	1	1
Self 0.25	1.34	1.57	1.16	1.9	1.66	0.87
Self 0.5	1.37	1.86	1.35	1.14	1.87	1.64
Self 1	1.6	4.18	2.6	1.69	3.31	2.04

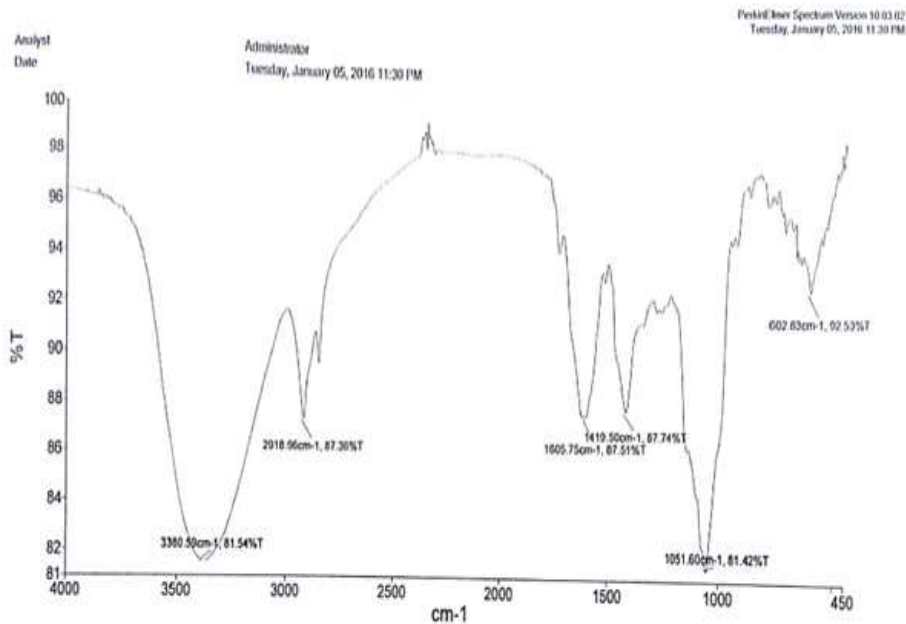


Fig. 1. FT-IR spectrum of *D. sophia* powder

Fourier Transform InfraRed (FT-IR)

According to the FT-IR spectrum (Fig. 1), it was found that:

In the 3200-3650 cm^{-1} area, the *D. sophia* gum has an alcoholic agent, presence of the absorption peaks in this area is usually because of the tensile vibration between hydrogen and another atom. The absorption peaks in 3100-3700 cm^{-1} area given their wideness are related to the alcohol.

In the 2850-3000 cm^{-1} area there are CH Aliphatic related vibrations.

In the 1600-1690 cm^{-1} absorption peaks are due to C = C tensile vibrations according to which useful information about Olefin's structures can be gained.

In the 700-1500 cm^{-1} area's absorption spectra small differences in a molecule's structure and components

result in major changes in absorption peaks' distribution. Because of this complex ion careful interpretation of this area's spectra is barely possible. In general, due to lack of carbonyl and carboxyl agent this gum isn't sensitive to pH and ionization doesn't have any effect on it, so it's not dependent on pH (Paradkar and Irudayaraj, 2002; Skoog and West, 1997).

Particle size evaluation

According to Stokes' law, particle size can affect the sedimentation rate, then the effect of gums on diameter of *D. Sophia's* diameter has been investigated and showed that sedimentation rate increased as particle size reduced.

Sedimentation rate evaluation

According to the Stokes's law formula (Eq.5) it is deduced that viscosity increase results in sedimentation rate decrease and it is expected that viscosity increase would delay particles sedimentation, but sedimentation is dependent on other factors too, that by using the data obtained from practical sedimentation rate evaluation towards the control sample, it was deduced that it is consistent with the Stokes's law and the maximum viscosity doesn't necessarily have the minimum sedimentation rate but water absorption by the particles, increase in their diameters (particle's size evaluation), hydrodynamic radius, developing gel network, synergistic state, and attraction and repulsion between their particles can result into stability increase and sedimentation rate decrease. This conclusion is concordance with Foroughinia *et al.* research in 1388 which was studied about doogh (an Iranian yoghurt beverage) (Foroughinia *et al.*, 2009).

In the Stokes's law theory towards the control sample, if the value was near 1, it could be said that sedimentation rate reduce is due to viscosity increase. In the formulation 2 which acid and essence were used sedimentation rate practically increased in compare to the formulation 1.

According to Stokes's law theoretical and practical ratio in both formulations is same as Table 5:

Microbial evaluation

The microbial evaluation results show that (Fig.2) at the day 0 the extracted treatments containing *D. sophia* gums had the maximum colony value due to the extraction conditions and the minimum colony growth was seen in the treatments containing xanthan and CMC. The number of the treatments containing xanthan and CMC colony increased in time but it was a little reduced in the treatment containing *D. sophia* gum which can be because of the bacteria feeding nutrients and loss of them. At the end of the storage period the amount of the colonies growth in all the treatments was more than the standard limit ($3.0 \pm 60.52 \log \text{CFU/g}$). Because pasteurization heat treatment was used for this beverage, this storage time was overabundance for it and the optimum storage time should be less or a stronger heat

treatment, like sterilization, should be used (Iranian National Standardization Organization).

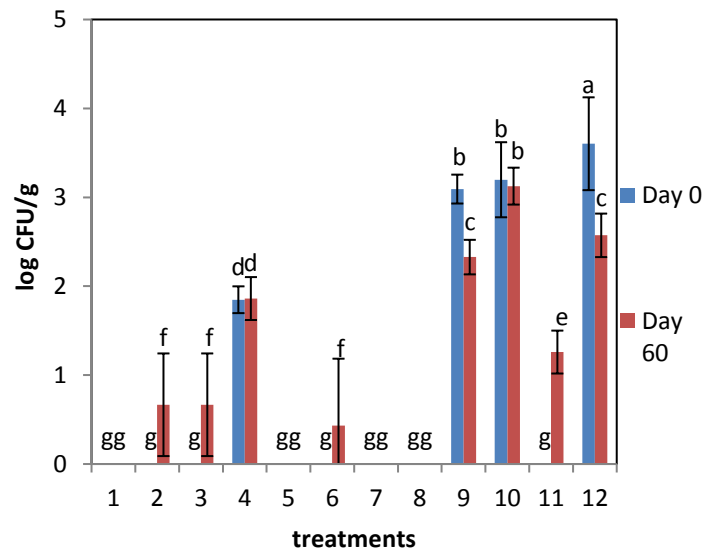


Fig.2. Bacterial growth at day 0 and day 60

The common letters imply inexistence of the significant difference at 5% level

Sensory evaluation

In this evaluation, according to the formulations 1 and 2 it was deduced that except *D. sophia* gum, which was even added by more percentage to the *D. sophia* beverage in compare to other gums, other gums didn't have much effect on samples' taste, color, smell, mouth feel, and general admission and the samples tested by evaluators were accepted. Also by applying pasteurization heat treatment to the secondary samples there wasn't any changes in beverage's sensory properties which was consistent with Behbahani and Abbasi (1393) study (Behbahani and Abbasi, 2014; Saricoban and Yilmaz, 2010). The results of sensory evaluation have been indicated in Fig. 3.

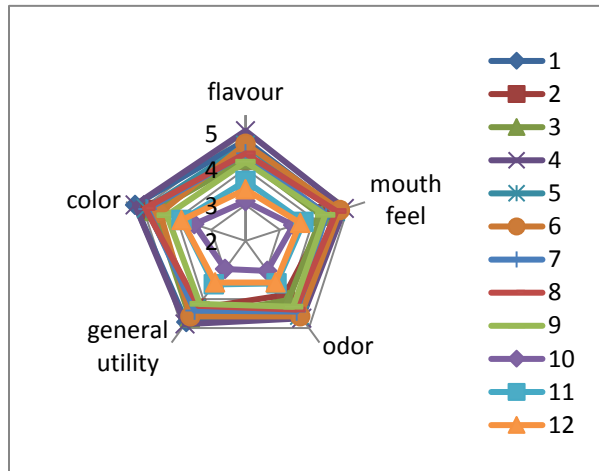


Fig. 3. Sensory evaluation of different treatments

4. Conclusion

According to the evaluations made and the results gained it was determined that xanthan – guar gum and xanthan gum in 0.05g level had the maximum effect on the *D. sophia* particles stabilization. After examining samples color and turbidity it was seen that gums had affected color and turbidity, especially, *D. sophia* gum which because of having color caused turbidity in the products but CMC gum showed minimum effect on increasing samples color and turbidity. In evaluating pH, acidity, and absorption during 2 months biweekly it was shown that pH and acidity didn't have much change and varied in standard range but absorption increased during time due to dissolution of more substances in the solution. *D. sophia* gum compounds were determined by FT-IR evaluation and it was deduced that this gum isn't dependant on pH. Microbial evaluation during storage also showed that the extracted *D. sophia* gum increased microbial contamination due to extraction steps and 2 months storage wasn't suitable for this product so less time is desirable for storage. This beverage was desirable in terms of sensory properties and except treatments containing *D. sophia* gum, other treatments were accepted by evaluators.

Food industries are constantly looking for economic and innovative ways of generating food products with more desirable textural and organoleptic properties to

meet consumers requirements so by stabilization of *D. sophia* beverage and use new sensory characteristic partly we can reach to that goal.

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