ISSN 2277-3657
Available online at www.ijpras.com

Volume 4, Issue 2 (2015):127-131

Research Article

International Journal of Pharmaceutical Research & Allied Sciences

Temperature Affection on Rheological Behavior of Apple-Banana Juice

Bahare Hajirostamlo*[1], Farnoosh Hasanpour[2], Julijana Tomovska [3], Mohammad Ali Shariati[4]
1. Young Researchers and Elite Club, Marand Branch, Islamic Azad University, Marand, Iran.
2. Department of Food Science and Technology, Khorasgan(Isfahan),Branch, Islamic Azad University, Isfahan, Iran.
3. Faculty of Biotechnical sciences, University,, St. Kliment Ohridski" "Partizanska bb" 7000 Bitola, Macedonia.
4. Department of Food Science and Technology, Science and Research Branch, Islamic Azad University, Tehran, Iran.
*corresponding author email:bhr214@yahoo.com

Subject: Food Technology

Abstract
Banana-apple juice is one of the most delicious juices. In this research, influence of temperature on the rheological behavior of banana-apple juice has been studied. The measurements were performed by capillary viscometer in 20, 40 and 60 °C. Results showed that the kinematic viscosity decreased with increasing temperature, and the temperature dependency of viscosity was found to follow the Arrhenius model. The activation energy and μ_∞ were 11.68699 *Kj/g mole* and 1.73×10^{-5} *Pa.s*. Also banana-apple juice showed Newtonian behavior.

Key words: *viscosity, temperature, banana-apple juice*

Introduction
Viscosity defines as internal friction of a liquid, on the other side liquid resistance against flowing. In most case of foodstuffs, knowing the type of viscosity is really important because through that the most appropriate devices can be selected in this way. In some processes, viscosity remarkably changes which is observed mostly in heating, cooling, homogenization, concentration and industrial fermentation as well therefore in designing of the processes, viscosity changes considers. From the quality control measurement view, foodstuffs are containing special constant especially in cream, yogurt, tomato paste and mustard sauce. When we reverse upside-down a liquid. When some of the fluid meets gravity force, they easily flow hence, regarding the measurement of liquid intensity, viscosity uses as a measuring tool so that whatever fluid resistance increases, its race is less than in an equal tension so viscosity is flow race parameter. The target of this study was to measure viscosity of apple-banana juice in market and determination of its viscosity dependent to temperature. Focusing on the assessment of juices viscosity is much important in consumer acceptance and sensory properties of a beverage before distribution in market (Ghafari et al , 2013; Raeisi Ardali et al, 2013; Raeisi Ardali et al, 2014). Regarding this point, this study aims at the measuring viscosity of mixed Banana-apple juice.

Table 1. Depicts all the required tools in this study

	Laboratory tool		Laboratory tool
1	capillary tube viscometer	5	Water bath (20, 40 and 60)
2	picnometer	6	Apple-banana juice purchased from Takdaneh Co
3	Chronometer	7	Balance with 0.0001 accuracy
4	Poar		

Material and methods

Viscosity measurement

In order to measure viscosity, viscometer model Ostwald-Cannon-Fenske used. Viscometer accurately fills with liquid up to A sign level, then liquid is vacuumed to another branch of pipe. Required time for dropping liquid from B to C zone registered when liquid flowed through capillary tube. Equation (1) used to determine viscosity;

Equation (1) $\frac{\mu}{p} = \alpha t$

In which;

μ is viscosity.

p is density

t is flow time.

α is viscosity conversion factor.

The amount of α is liquid dependence. The amount of α is liquid dependence where distilled water has considered as liquid.

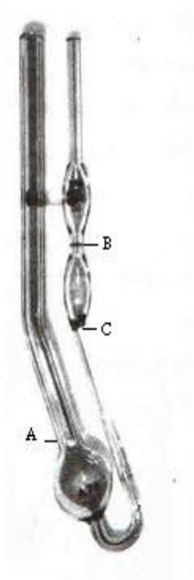

Figure 1. Schematic of Ostwald-Cannon-Fenske

Flow time (s) measured at 20, 40 and 60 in 3 replicates for reference liquid and sample. Obtained results have summarized in table 2 (a,b).

Table 2 (a): time for distilled water flow

	Time			
Temperature (°C)	1	2	3	Average
20	3.38	3.47	3.41	3.42
40	2.83	2.93	2.99	2.91
60	2.63	2.59	2.55	2.59

	Time			
Temperature (°C)	1	2	3	Average
20	6.54	6.61	6.57	6.57
40	6.28	6.44	6.34	6.35
60	5.81	5.87	5.73	5.80

In addition, density measured as follows;
First, density measured by pincometer in 3 temperatures including 20°C, 40°C and 60°C, then:

1) Mass of Picnometer and liquid: m_3
2) Mass of dried and empty picnometer: m_1
3) Mass of liquid: m_L
4) Mass of picnometer and reference liquid: m_2
5) Mass of the liquid volume :m_r

Equation (2): $SG = \frac{m_3 - m_1}{m_2 - m_1} = \frac{m_L}{m_r}$

$P_T = (SG)_t \times P_r$

In which;

$(SG)_t$ is special gravity.

P_r is liquid density at required temperature.

P_r is water density at required temperature.

Table 3 shows physical properties of apple-banana juice.

Table 3. Physical properties of water in saturate pressure and obtained results for banana-apple juice

Temperature (°C)	Density of banana-apple juice (PKg/m^3)	Special viscosity of banana-apple juice (SG)	Water density P (Kg/m^3)	Special viscosity of water μ (PG.S) × 10 $^{-6}$
20	1051.0048	1.0529	998.2	993/414
40	1050.4421	1.0587	992.2	658/026
60	1049.7626	1.0677	983.2	471/650

Equation3 used to measure viscosity in 3 aforementioned temperatures.

Equation (3): $\frac{\mu}{\mu r} \cdot \frac{Pr}{P} = \frac{t}{tr}$

r index is related to reference liquid.

Table 3: water and apple-banana juice viscosities

Temperature (°C)	Absolute viscosity of Banana-apple juice μ (× 10 $^{-6}$ PG.S)	water absolute viscosity μ (× 10 $^{-6}$ PG.S)
20	2009.335	993.414
40	1520.1859	658.026
60	1127.7098	471.650

The affection of temperature on viscosity

Viscosity is really dependent to temperature thus controlling it in determination of viscosity when preparing of viscosity data is really important. By increasing temperature, viscosity reduces. Temperature affection on foodstuff viscosity expresses by the following equations;

Equation (4); $\mu = \mu\infty \cdot e^{\frac{Ea}{RT}}$

Equation (5); $\text{Ln}\ \mu = \text{Ln}\ \mu_\infty + \frac{Ea}{R} \cdot \frac{1}{T}$

E_a: activation energy constant (KJ/mol)

μ_∞: Arenius constant

R: global gas constant (8.314×10^{-3} kj/molK)

T: Temperature base on (kelvin)

Equation (5) considers as y=a + bx thus;

y= Ln μ ,a= Ln μ∞.X= 1/T ,B= Ea/R

Results and discussion

Prediction of viscosity in slightly temperature base on degrees centigrade

Finally, regarding prediction of viscosity in determined temperature base on degrees centigrade as follows;

Excel software used to draw curve (Ln μ vs. 1/T). Base on the regression equation; a and b determined. Table 4 and figure 1 depicts data used.

Table 4: data applied in linear regression

T	$\frac{1}{T}$	**μ**	**Ln μ**
293	**0/003412969**	**2009/335 × 10 $^{-6}$**	**-6.21**
313	**0/003194888**	**1520/1859 × 10 $^{-6}$**	**-6.4889**
333	**0/003003003**	**1127/7098 × 10 $^{-6}$**	**-6.7875**

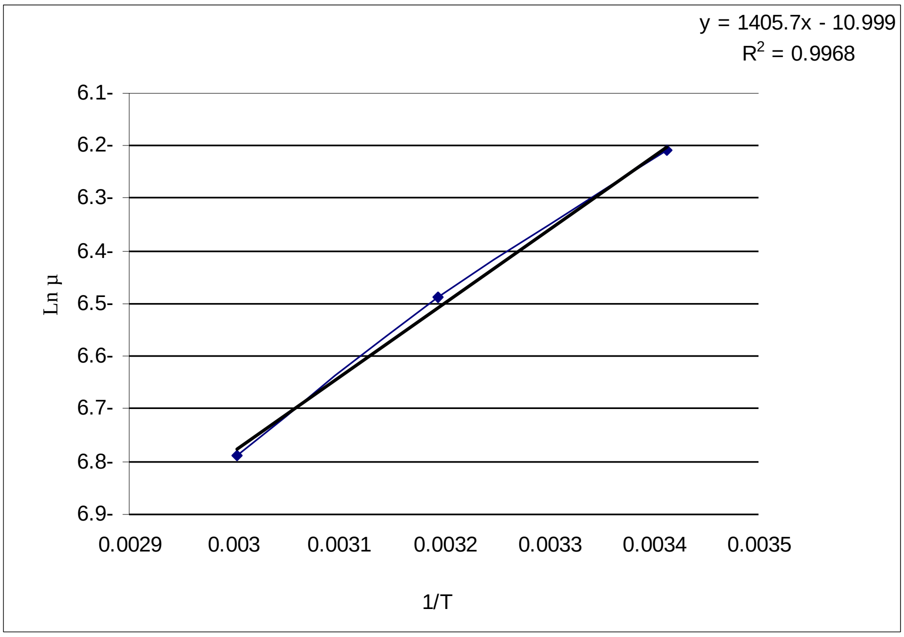

Figure 1. Changes curve ($\frac{1}{T}$ Vs **Ln** μ)

Base on obtained equation; following is possible:

$$\frac{Ea}{R} = 1405.7$$

$$\text{Ln } \mu_{\infty} = -10.999$$

$$\mu_{\infty} = e^{-10.999} = 1.73 \times 10^{-5}$$

By measured coefficient in Arenius coefficient; equation 6 obtains;

Equation (6) $\mu = 1.73 \times 10^{-5}\, e^{\frac{1405.7}{273+t}}$

And finally equation (6) can be used in measurement of viscosity by using measured coefficients in Arenius equation .

Table 5. Measured viscosity for 20°C, 40°C and 60°C using Arenius

Temperature	**Equation**	**Measured viscosity (PG.S× 10 $^{-6}$)**
20	$\mu = 1.73 \times 10^{-5}\, e^{\frac{1405.7}{273+t}}$	2066.6 × 10 $^{-6}$
40	$\mu = 1.73 \times 10^{-5}\, e^{\frac{1405.7}{273+t}}$	1522.42 × 10 $^{-6}$
60	$\mu = 1.73 \times 10^{-5}\, e^{\frac{1405.7}{273+t}}$	1163.45 × 10 $^{-6}$

References

1. Ghafari, Z., Hojjatoleslamy, M., R Shokrani, Shariaty, M, A.2013. Use of Date Syrup As a Sweetener in Non-Alcoholic Beer: Sensory and Rheological Assessment. Journal of Microbiology, Biotechnology and Food Sciences, 3(2): 182-184.
2. Raeisi Ardali, F., Hojjatoleslamy, M., Razavai, S,H., Bahman, M., Shariati, M,A. 2013. Investigation of Rheological Properties of Enriched Grape Juice with Rice Brown Extraction. Iranian Food Science and Technology Research Journal, 9(1): 50-60.
3. Raeisi Ardali, F.,Rahimi, E., Tahery, S., Shariati, M, A. Production of a New Drink by Using Date Syrup and Milk. 2014. Journal of Food Biosciences and Technology. 4(2): 67-72.