American Journal of Food Science and Nutrition 2015; 2(4): 49-54 Published online August 10, 2015 (http://www.aascit.org/journal/ajfsn) ISSN: 2375-3935



Keywords

Apple Vinegar, White Vinegar, Red Vinegar, Physicochemical Propertie

Received: July 15, 2015 Revised: July 24, 2015 Accepted: July 25, 2015

Comparing Physicochemical Properties of Three Types Iranian Vinegars

AASCIT

American Association for

Science and Technology

Hamid Golivari^{1, *}, Razieh Niazmand², Mostafa Shahidi Noghabi²

¹Department of Food Science and Technology, Azad Islamic University of Damghan, Damghan, Iran

²Department of Food Chemistry, Research Institute Food Science and Technology, Mashhad, Iran

Email address

food_qc@yahoo.com (H. Golivari)

Citation

Hamid Golivari, Razieh Niazmand, Mostafa Shahidi Noghabi. Comparing Physicochemical Properties of Three Types Iranian Vinegars. *American Journal of Food Science and Nutrition*. Vol. 2, No. 4, 2015, pp. 49-54.

Abstract

Some physicochemical properties of vinegar such as (brix, acidity, densitometry, total sugar, alcohol, color, phenolic content, FRAP and metallic contamination) affect on its quality and safety. In this study, three different types of Iranian tradition vinegar (apple, white, and red) were procured from local market of Damghan, Iran. The samples were studied for brix, acidity, densitometry, total sugar, alcohol, color, phenolic content, FRAP and metallic contamination tests. The results revealed that apple vinegar has more brix, density, TPC, antioxidant activity, and zinc than the other vinegars. As well as, color densities of apple and red vinegar have not significant difference; however, these values were measured more than white vinegar. White and red vinegars have the highest acidity among the three type vinegars. TPS and antioxidant activity of white and red vinegars together have not significant difference. Amounts of alcohol, arsenic, lead, and copper of the three type vinegars have not significant difference.

1. Introduction

Vinegar is derived from the French word "Vinaigre" meaning sour wine. Vinegar is a liquid that is achieved by fermentation of alcohol to acetic acid, in a manner that other byproducts not be generated in the fermentation. Generally, acetic acid concentration is containing 4% to up 8% of vinegar volume (commonly 5%) although it is possible that the minimum concentration is less in some countries. In addition, natural vinegars are containing a small amount of tartaric acid, citric acid, and other acids (Conner and Allgeier, 1976). pH of vinegar is varied from 2 to up 3.5. However, commonly commercial vinegar has pH 4.2 this value is depended to acetic acid content (Chang et al., 2005).

Acetic acid is produced by artificial and bacterial fermentation methods. Nowadays, only 10% of vinegars are produced by the second method. However, this method is advised giving to nutritional aspects. About 75% produced acetic acid for industrial using in world is produced by carbonize methanol, and for other usage, it is produced by other methods (Nanda et al., 2001). Physicochemical properties of vinegars can be different based on type of fruit, production method and conditions. The properties such as density, color, total phenolic compounds (TPC), antioxidant activity, total sugar, alcohol content, and metallic contamination affect on the quality of vinegar. In addition, some this properties such as metallic contamination, influence on the safety of vinegars. Therefore, measurement these properties in various produced vinegars can give useful data about quality of various vinegars (Botella et al., 2000).

To date there is no study available in the literature concerning the physicochemical properties of Iranian tradition vinegars. Hence, the objective of this work was to study the physicochemical properties of these vinegars in order to improve the quality of these products with presenting the applicable results.

2. Materials and Methods

2.1. Materials

All solvents and reagents were analytical grade and prepared from Merck and Sigma-Aldrich companies. Vinegar samples (apple, white, and red vinegars) were randomly procured from local market of Damghan, Iran.

2.2. Brix

Brix of the samples were measured using refractometer (schmidt+haensch, Germany) at 20 °C and was reported as g per 100 g the sample (Heckert, 1990).

2.3. Total acidity

Total acidity of the samples was measured by potentiometric method that was described by Kotani and Miyaguchi (2003) and following formula:

$$A = V \times 0.0064 \times 100/m$$

Where A represents total acidity as citric acid (g per 100 g sample), V (mL) and m (g) are volume of used NaOH (0.1 N) and mass of sample, respectively.

2.4. Density

Density of the vinegar was calculated giving the method described by Masino and Chinnici (2008).

2.5. Total Sugar

5 mL of fehling A and 5 mL of fehling B solutions were mixed and boiled for 2 min. Then, the neutralized solution was added gently to fehling solutions until the blue color changes to brick red color of Cu_2O . Total sugar of of the vinegar was calculated giving the following formula:

$$N = F \times 100 \times 100 \times 100 / V \times 25 \times 25$$

Where N (g per 100 g sample) represents total sugar, F and V (mL) are fehling factor and volume of used solution, respectively.

2.6. Alcohol

10 g the sample was neutralized with NaOH (0.1 N) and then alcohol of sample was removed by distillation. 10 mL distilled water was poured in an Erlenmeyer (as control) and 10 mL condensed liquid was poured in another Erlenmeyer. Afterward nitro-chromic solution was added to both them and the erlenmeyers were stored at 18-20 $^{\circ}$ C in dark place for 30

min. After this time, 50 mL distilled water and 1 g KI were added to it, after 1 min, it was titrated with sodium thiosulfate (0.1 N) change color from yellow to blue. Amount of alcohol was calculated giving following formula (Yang and Qi, 2011):

$$A = (V_1 - V_2) \times 0.0015 \times 250 \times 100 / V_0 \times m$$

Where A (g per 100 g sample) is amount of ethanol, V_1 (mL), V_1 (mL), V_0 (mL), and m (g) are volume of used sodium thiosulfate for the control solution, volume of used sodium thiosulfate for the sample, volume of used condensed liquid, and mass of the sample, respectively.

2.7. Color

30 mL ethanol was added to 0.5 g of the sample. Then returned distillation was carried out for 2.5 h. After cooling, the extracted solution was filtered and its optical absorbance was measured by UV-160A spectrophotometer (Shimadzu, Japan) at 425 nm. Color intensity was calculated giving following formula (Lopez et al., 2005):

Color intensity = $A \times D \times 100 / E\%^{1} cm \times m$

Where A, m, D, and $E\%_{cm}^1$ are measured absorbance, mass of the sample, dilution of the extracted solution, and specific absorbance of 1% solution in a cell with 1 cm diameter, respectively.

2.8. Total Phenolic Compounds (TPC)

TPC of the vinegars were measured by Folin-Ciocalteu method (Ordoeez et al., 2006). Briefly, 0.5 ml the sample was mixed with 2.5 ml Folin-Ciocalteu reagent and 2 ml sodium carbonate solution (7.5%). The mixture stored at room temperature for 120 min then absorbance of the solvent was read at 760 nm.

$$T_{P} = A_2 C.2/A_1$$

where T_p (µg/L) represents phenolic compound content, C (µg/L), A₁ and A₂ are, concentration of standard Gallic acid, absorbance of standard Gallic acid and absorbance of the sample, respectively.

2.9. Ferric Reducing Antioxidant Power (FRAP)

Standard solutions of FeSO₄ were prepared at concentrations of 200 to up 2000 μ m/L. 30 μ L standard solutions, 900 μ L FRAP, and 90 μ L deionized water were mixed in a capillary tube and was put within water bath at 37 °C. After reaching temperature to 37 °C, absorbance of the samples was measured at 595 nm using UV-160A spectrophotometer (Shimadzu, Japan) and amount of Fe²⁺ was calculated giving the following formula: (Verzelloni et al., 2007):

Where Y (µm/L) and X are amount of iron and absorbance

at 595 nm, respectively.

2.10. Metallic Contamination

Amount of the heavy metals containing arsenic, lead, copper, and zinc were measured by atomic absorption method that was described by Ping and Huan (2001). For this purpose, at first the samples were digested. Briefly, 5 g the sample and nitric acid were mixed in a 10 mL Erlenmeyer then it stored at 80 °C for 24 h. As well as, a control sample that was contained 5 mL water instead of vinegar was prepared and injected to furnace.

2.11. Statistical Analysis

All experiments and measurements were carried out in

triplicate. The statistical analysis was performed by completely randomized design through Minitab 16 software. Significant differences between means were determined by Duncan's multiple range tests; P values less than 0.05 were considered statistically significant.

3. Results and Discussion

Brix (°Bx) is used as an index for amount of sugar (Liu et al., 2007). Giving Fig. 1 apple vinegar has significant more °Bx (3.8%) compared to the other vinegars. However, °Bx of white and red apple vinegars had not significantly difference with each other. Apple and white vinegars have the most and the least °Bx, respectively (Fig. 1).



Fig. 2. Acidity of the different Iranian vinegars.

Fig. 2 shows that acidity of apple vinegar was significantly less than the other vinegars. In addition, acidity of white and red vinegars has insignificant difference with each other. White and apple vinegars have the most and the least acidity, respectively (Fig. 2). According to Iranian National Standard (INS) at least acceptable level of acidity as acetic acid for vinegar is 5 g/100 mL (Iranian National Standard, 2012); however, the acidity of apple vinegar was measured less this

standard value.

Fig. 3 describe that density of apple vinegar was significantly more than the other vinegars (P<0.05). However, density difference between white and red vinegars was in ten thousandth level, the significant difference was not observed between them (P>0.05). Apple and white vinegars have the most (1.007) and the least (1.004) density, respectively (Fig. 3).



Fig. 4. Total sugar of the different Iranian vinegars.

Giving Fig. 4, total sugar of vinegar was significantly more than the other vinegars (P<0.05), whereas, density difference between the two other vinegars was insignificant (P>0.05). Apple vinegar has the most total sugar (0.24) (Fig. 4).

Although amount of alcohol in the three types vinegars have not significant difference, average amount of alcohol of apple vinegar was higher than the other vinegars. Yang et al. (2011) reported that apple vinegar has more alcohol compared to other vinegars. This is due to apple has a lot of sugar and so larger amounts of ethanol in it has not converted to acetic acid under oxidation process. According to INS permissible maximum level of ethanol in vinegar is 0.5% (Iranian National Standard, 2012). The result of this study showed that average amount of alcohol in the three types vinegars where less than this standard limit.

Color intensity of apple and red vinegar has not significant difference. However, color intensity of white vinegar was measured significantly less than the other vinegars. This is probably due to perform bleaching stage during production of this type vinegar (Fig. 5).



Fig. 5. Color intensity of the different Iranian vinegars.



Fig. 6. Phenolic compounds of the different Iranian vinegars.

Fig. 6 shows that TPC of apple vinegar was significantly more than the other vinegars. However, TPC of white and red vinegars have insignificant difference with each other. TPC of apple and white vinegars have the highest (15 mg/mL) and the lowest (1 mg/mL) TPC, respectively (Fig. 6).

Giving Fig. 7, antioxidant activities of white and red

vinegars have not significant difference with each other; however, antioxidant activity of apple vinegar was significantly more than the other vinegars (P<0.05). The highest (2.76 μ M/g) and lowest (0.1 μ M/g) antioxidant activity were observed for apple and white vinegars, respectively (Fig. 7).



Fig. 7. Iron reducing power of the different Iranian vinegars.

Verzelloni et al. (2007) study relationsheep between the antioxidant properties and the phenolic and flavonoid content in traditional balsamic vinegar. Their results revealed that antioxidant property is increased with increasing phenolic and flavonoid contents (Verzelloni et al.,2007).

Matsuura et al. (2007) evaluate antioxidant activity and characterization of antioxidant phenolics in the plum vinegar extract of cherry blossom (Prunus lannesiana) and they reported that the vinegar has more antioxidant activity than red vinegar (Matsuura et al., 2007).

Results of the metallic contamination revealed that amount of arsenic in each of the three vinegars were measured 0.002 mg/L (Table 1), which the value is less than standard limit of INS (1 mg/L). Lead and copper contents in each of the three vinegars have insignificant difference (P>0.05). The highest lead and copper contents were measured for red and white vinegars, respectively (Table 1). Giving Table 1, zinc content of apple vinegar (0.3126 mg/L) was very more than the other vinegars. On other hand, insignificant difference was observed for zinc content of white and red vinegars (P>0.05).

Table 1. Amount of Heavy metals in the different Iranian vinegars.

Vinegar type	As	Pb	Cu	Zn
Apple	0.002 a	0.0029 a	0.0326 a	0.3126 a
White	0.002 a	0.0019 a	0.0640 a	0.0813 b
Red	0.002 a	0.0031 a	0.0473 a	0.0760 b

Different letters within the columns indicate significant difference (P < 0.05).

4. Conclusions

Giving the results, apple vinegar has more brix, density, TPC, antioxidant activity, and zinc than the other vinegars. As well as, color densities of apple and red vinegar have not significant difference; however, these values were measured more than white vinegar. White and red vinegars have the highest acidity among the three type vinegars. TPS and antioxidant activity of white and red vinegars together have not significant difference. Amounts of alcohol, arsenic, lead, and copper of the three type vinegars have not significant difference.

References

- Botella, P., Corma, A., Lopez-Nieto, J.M. 2000. Acylation of toluene with acetic anhydride over beta zeolites: influence of reaction conditions and physicochemical properties of the catalyst. Journal of Catalysis, 195(1), 161-168.
- [2] Chang, R., Lee, H., Ou, A.S. 2005. Investigation of the physicochemical properties of concentrated fruit vinegar. Journal of Food and Drug Analysis, 13(4), 348-356.
- [3] Conner, H.A., Allgeier, R.J. 1976. Vinegar: its history and development. Advanced Applied Microbiology, 20, 81-133.
- [4] Heckert, D.C. 1990. Method of preparing fruit juice beverages and juice concentrates nutritionally supplemented with calcium, Google Patents.
- [5] Kotani, A., Miyaguchi, Y. 2003. A disposable voltammetric cell for determining the titratable acidity in vinegar. Analytical Sciences, 19(11), 1473-1476.
- [6] Liu, F., He, Y., Wang, L. 2007. Application of Least Squares-Support Vector Machine for Measurement of Soluble Solids Content of Rice Vinegars Using Vis/NIR Spectroscopy. Computational Intelligence and Security, 2007 International Conference on, IEEE.

- [7] Lopez, F., Pescador, P., Guell, C. Morales, M.L., Garcia-Parrilla, M.C. 2005. Industrial vinegar clarification by cross-flow microfiltration: effect on colour and polyphenol content. Journal of Food Engineering, 68(1), 133-136.
- [8] Masino, F., Chinnici, F. 2008. A study on relationships among chemical, physical, and qualitative assessment in traditional balsamic vinegar. Food Chemistry, 106(1), 90-95.
- [9] Matsuura, R., Moriyama, H., Takeda, N., Yamamoto, K. 2007. Determination of antioxidant activity and characterization of antioxidant phenolics in the plum vinegar extract of cherry blossom (Prunus lannesiana). Journal of Agricultural and Food Chemistry, 56(2), 544-549.
- [10] Nanda, K., Taniguchi M., Ujike, S., Ishihara, N. 2001. Characterization of acetic acid bacteria in traditional acetic acid fermentation of rice vinegar (komesu) and unpolished rice vinegar (kurosu) produced in Japan. Applied and Environmental Microbiology, 67(2), 986-990.
- [11] Ordonez, A.A.L., Gomez, J. D., Vattuone, M. A., Isla, M.I. 2006. Antioxidant activities of sechium edule (Jacq) Swartz extracts. Food Chemistry, 97, 452-458.
- [12] Ping, X., Huan, S. (2001). Study on Determination of Arsenic in Vinegar. Journal-Taiyuan University of Technology, 32(2), 199-201.
- [13] Sossou, S.K., Ameyapoh, Y., Karou, S.D., De Souza, C. 2009. Study of pineapple peelings processing into vinegar by biotechnology. Pakistan Journal of Biological Sciences, 12(11), 859-865.
- [14] Verzelloni, E., Tagliazucchi, D., Conte, A. 2007. Relationship between the antioxidant properties and the phenolic and flavonoid content in traditional balsamic vinegar. Food Chemistry 105(2), 564-571.
- [15] Yang, H.L., Qi, Z. 2011. An optimum medium designed and verified for alcohol vinegar fermentation. African Journal of Biotechnology, 10(42), 8421-8427.