Journal of Food Biosciences and Technology,
Islamic Azad University, Science and Research Branch, Vol. 4, No. 2, 27-32, 2014

Evaluation of Solvent Extraction Efficiency –Chemical Analysis of the Oil Extracted from Apple Seeds

M. Azizi [a*], A. A. Safekordi [b]

[a] *Ph. D. Research Student of the Department of Food Engineering, Science and Research Branch, Islamic Azad University, Tehran, Iran.*
[b] *Professor of the Department of Food Engineering, Science and Research Branch, Islamic Azad University, Tehran, Iran.*

Received: 17 January 2014 Accepted: 10 June 2014

ABSTRACT: Oils and fats are substances that are important nutritionally and have important role and impact on human health. Energy consumption and preservation in respect of food industry and the increase in the world population and search for new sources of oils and fats to full fill the need of the society particulary the nutritional requirements have introduced this research topic. Therefore aim of this work is to underestand the extraction efficiency of the solvents and to evaluate the extracted oil. Hexan and AW406 were employed to evaluate the extraction efficiency at 60, 80 and 100°C for a period of 30 minutes using Soxhlet apparatus as a mean to extract the oil. The extracted oil was subjected to a series of chemical analysis consisting of fatty acid composition, phospholipid concentration, percent nonsaponifiable matter, Induction period measurement, sterol and tocopherol composition and analysis. The result indicated that the solvent AW406 behavior depends on the temperature of extraction and longer period of extraction is required when AW406 is compared to n-hexane. Chemical analysis of the extracted oil indicated that linoleic and oleic acids were the predominant fatty acids present and β -sitosterol and α -tocopherol constituted the majority of the respective fractions. Due to the fact that extracted oil from apple seeds had approximately 89% of their fatty acid in the unsaturated form, mainly linoleic acid followed by oleic acid, the oil might be employed in food and pharmaceutical products.

Keywords: *Apple Seed Oil, AW406, Extraction Efficiency, Oil Extraction, n-Hexane.*

Introduction

Oils and fats have been consumed by man directly or indirectly for years. A part of human diet has been based on oils and fats and this group of chemical substances have been employed in various food and pharmaceutical formulations.

The increase in the production of food with an increase in the world population and the fact that fats and oils constitute a large share of the market in the production of various food specifically the formulated ones, researchers have been interested to find new sources of oils and fats to full fill the need not only in term of formulation and presenting better texture, aroma and colour appearance but also provide the requirements nutritionally. Apart from the chemical and nutritional aspects one is looking for the least expensive source of energy to minimise the costs.

The first part of this research work is concerned with the effect of two different extracting solvents; n-hexane and AW406 on the oil extraction. The second part is concerned with chemical evaluation of the extracted oil.

The oil might be employed for various applications such as food formulation or pharmaceutical products (Hazrati *et al.*, 2012). According to the report (Verband der

*Corresponding Author: mohammadazizi87@gmail.com

deutschen Fruchtsaft-Industrie, 2012) in the year 2010 approximately 300.000 tons of apple pulps were produced in Germany and from this quantity 4000 tons of oil was extracted. This figure corresponds to 5% of the oil consumed in Iran in 1389 (Heidari *et al*., 2010). Therefore the aim of this research is to evaluate the efficiency of the extracting solvent and chemical characteristics of the oil extracted from seeds.

Materials and Methods

Apple seed samples were obtained from red lebonise apples maling (M106) Variety. All the chemicals were obtained from Merch Chemical Company, Germany. The solvent AW406 and n-hexane a by product of petroleum industry was obtained in Iran and the purity was examined by their application on to a GC apparatus (Golmohammad *et al*., 2007). The oil extraction was performed using soxhlet apparatus, employing 60, 80 and 100°C as the extraction temperature. The solvent consumed, its recovery, the speed of recovery and the maximum amount of extraction was evaluated (Wang & Weller, 2006).

The extracted oil was subjected to a series of tests to understand its chemical characterstics. The fatty acid composition was determined by the formation of fatty acid methyl esters and its application on to a varian gas chromatograph equipped with a cpsill 88 capillary column and flame ionisation detector according to Ghavami *et al*. (2008).

Phospholipids were quantitatively determined by ashing the samples and the treatment of the ash with ammonium molibdate as a reducing solution and sodium acetate and finally reading the absorption by spectrophotometer at 720nm and comparing the reading with the standards according to Ghavami *et al*. (2008).

The induction period of the oil that is its resistance to oxidation was determined by Metrohm Rancimat at 110°C with an air flow rate of 18-20 lit/h as described by Ghavami *et al*. (2008).

The nonsaponifiable matter of the oil was isolated by saponification of the oil with alcoholic potassium hydroxide solution followed by the extraction of the non saponifiable matter with ether. The nonsaponifiable matter was fractionated into numbers of chemical classes of compounds on thin layer chromatography plates covered with Silica Gel G type 60 using hexane: ether as developing solvents and spraying with Rhodamine 6G in ethanol according to Ghavami *et al*. (2008).

Sterols, the major fraction in the non saponifiable matter was isolated and identified employing GC apparatus equipped with SE54 capillary column and flame ionisation detector according to Ghavami *et al*. (2008). Tocopherols were determined by HPLC apparatus after their isolation on a TLC plate according to Ghavami *et al*. (2008).

All the tests were carried out in triplicate orders. SPSS software and Duncan test were applied for the statistical analysIs of the results.

Results and Discussion

The extraction efficiency of the solvents AW406 and hexane were evaluated and indicated that on average hexane showed a better extraction efficiency than AW406 (Figure 1).

Figure 2 Indicates the average extraction for the there temperatures employed (60, 80 and 100°C) with regard to the fixed period intervals of 30 minutes. It was concluded that the solvent hexane extracted 84% and the solvent AW406 extracted 90% of the total oil when the treatment was carried out for 120 minutes. For the remaining 60 minutes, the behaviour of the solvents were quite similar.

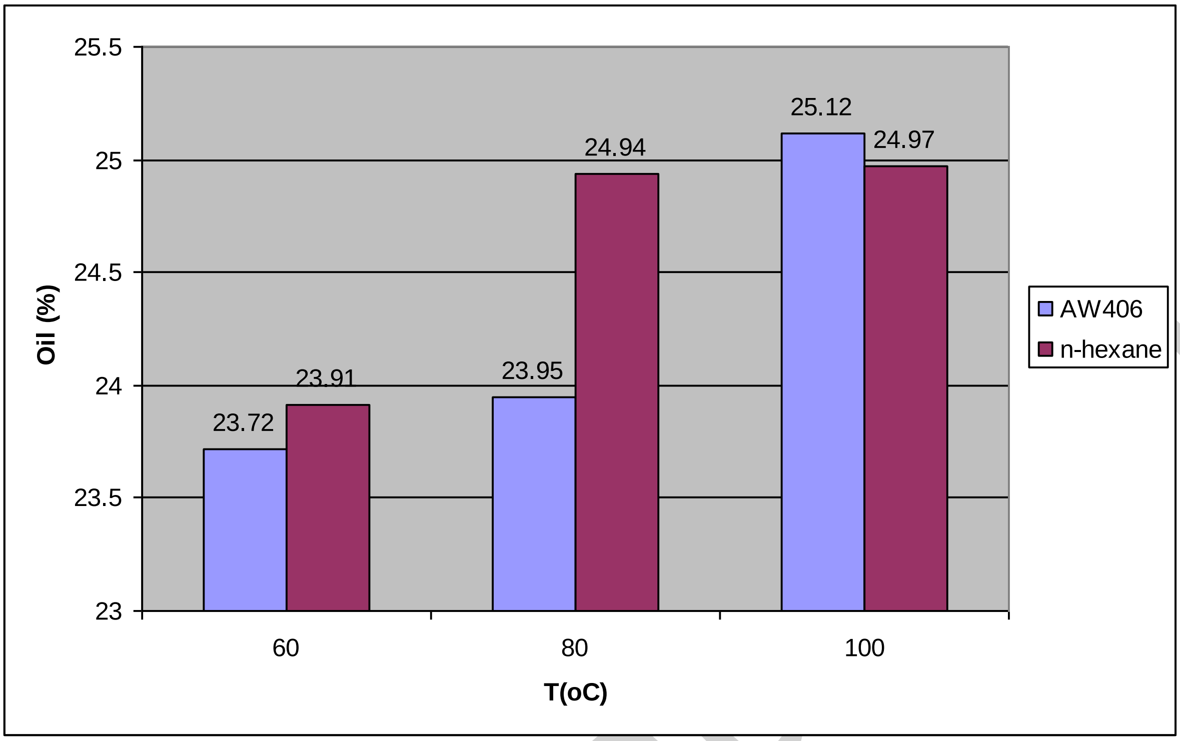

Fig.1. Comparison of the oil extracted from apple seed by normal hexane and AW406 solvents at constant temperature

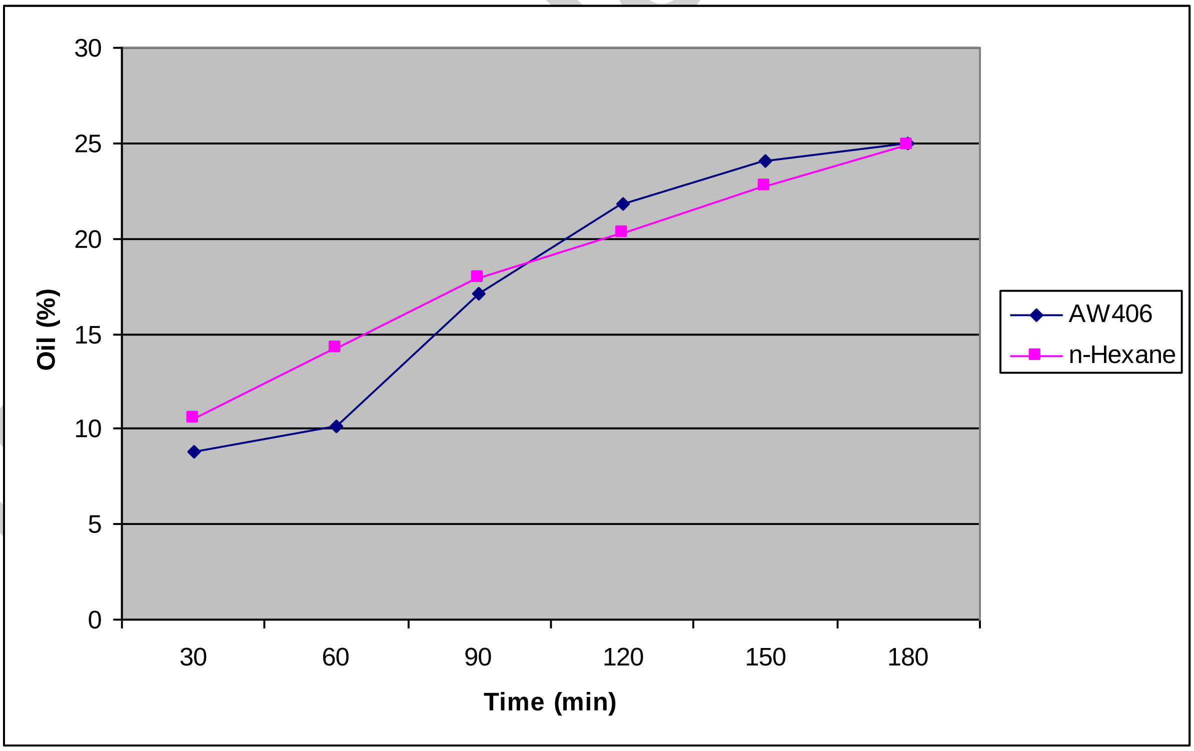

Fig. 2. Oil extraction rate at 60, 80 and 100°C

The extracted oil from apple seed might be considered as a valuable oil due to its chemical nature and characteristics namely the fatty acid composition. Table 1 presents the fatty acid composition of the extracted oil.

The oil might be considered as an oil rich in polyunsaturated fatty acids, quite similar to soyabean oil with the exception that α-linolenic acid is almost absent.

Moderate in linoleic and oleic acids and low in saturated fatty acid; makes the oil ideal for cooking and frying applications (Kelly, 2001) and might be also employed as salad oil.

The phospholipid concentration is about 775 ppm as phosphorous or 2.32% as phospholipid. Depending on the application, phospholipids might create some problems namely precipitation and flavour revision if the oil is subjected to elevated temperature. However due to emulsifying properties and synergistic activities, phospholipids might have further benificial applications in food formulations.

The natural characteristics and economical aspects of the oil suggest that the oil might not be recommended for hardening otherwise this group of polar lipids if remained in the oil might create problem and cause catalyst poisoning if hydrogenation is applied.

The extracted oil stability (4.8h) is quite similar to some vegetable oils such as grape seed oil (4.8h), maize oil (5.6h), canola (7.0h) sunflower seed oil (4.2h) and soyabean oil (4.6 h), as indicated by Ghavami *et al*. (2008).

The nonsaponifiable matter of the oil constituted 3.01% that consisted of sterols, 4methylsterols, triterpene alcohols, tocopherols, carotenoids and some non-polar compounds. The sterols and tocopherols are the predominant fractions in the nonsaponifiable matter of the oil. Table 2 presents the analysis of the sterols that is similar to other vegtable oils where β-sitesteral is the predominant sterol constituting over 83% of this fraction.

Table 1. Fatty acid composition of apple seed oil (%)

Common Name	**Formulation**	**Percent**
Lauric acid	C12:0	0.10
Myristic acid	C14:0	0.10
Palmitic acid	C16:0	7.60
Stearic acid	C18:0	1.70
Arachidic acid	C20:0	1.20
Behenic acid	C22:0	0.30
Palmitoleic acid	C16:1cis	0.20
Oleic acid	C18:1cis	36.60
Linoleic acid	C18:2cis	51.50
Linolenic acid	C18:3cis	0.70
Sum of saturated fatty acids		12.8
Sum of unsaturated fatty acids		87.2

Table 2. Sterol composition of apple seed oil (%)

Sterol	Percent
Brassicasterol	6.84
Campesterol	0.93
Stigmasterol	0.05
β-Sitosterol	83.45
Δ^5 Avenasterol	3.49
Stigmasta-5, 24(28)-dien-3-ol	0.55
Δ^7 Stigmastanol	3.89
Δ^7 Avenasterol	0.60

Brassicasterol, a rare sterol previously reported by Ghavami *et al*. (2008) to be present in canola up to 10% constituted about 6% of this fraction.

Identification and evaluation of tocopherols by HPLC indicated the presence of α-tocopherol (145ppm) as the predominant tocopherol (92.3%). Other tocopherols such as β, γ and δ-tocopherols were absent or only present in minute concentrations. Since the oil contains α-tocopherol the form that has higher vitamin E property and at the same time exhibits antioxidant activity with the specification stated earlier in respect of fatty acid and nonsaponifiable matter compositions, the oil might be considered as a valuable oil and might be employed for various applications.

Conclusion

The extraction of apple seed oil was studied using two different industrial solvents, hexane and AW406. The effect of temprature, time, amount and kind of solvent on extraction efficiency was studied and concluded that by increasing the temperature, the efficiency of n-hexane remains almost constant while that of AW406 is increased. The solvent n-hexane extracted a considerable portion of the oil in a shorter time while the solvent consumption for hexane is higher for the extraction of equal quantity of the oil as compared to AW406.

The oil being liquid at room temprature, having a high induction period and stability, containing phenolic compounds namely α-tocopherol, and a desired fatty acid composition interm of high mono and polyunsaturated fatty acids and low saturated fatty acids with a fruity and desirable taste and aroma, might be considered as a healthy oil and might be employed and consumed in various formulations and applications.

References

Ghavami, M., Gharachorloo, M. & Ghiassi Tarzi, B. (2008). Experimental Techniques of Oils and Fats, Islamic Azad University, Science and Research Branch.

Golmohammad, F., Sadeghi Fateh, D., Shahvelayati, A., Shokrollah Zadeh, S. & Shokoohi, H. (2007). The removal of benzene from petroleum solvent 406AW help polar organic solvents and compare their performance. Journal of Chemical Engineering, Vol. 26, No. 3, pp. 1-7.

Hazrati, S., Alirezalu, K., Tahmasbi Sarvestani, G. & Alirezalu, A. (2012). Journal of Medicinal Plants, Vol. 2, No. 9.

Heidari, Kh., Kavoon, M., Otfovan, M. & Pirooz, A. (2010). Vegetable oil market, Institute of Business Studies and Research.

Kelly, G. S. (2001). Conjugated Linoleic Acid: A Review, ND Alternative Medicine Review, 6(4), 367-382.

Verband der deutschen Fruchtsaft-Industrie, e. V. (VdF) (2012). Geschaftsbericht 2009, bonn, Germany.

Wang, L. & Weller, C. (2006). Recent advances in extraction of nutraceuticals from plants. Trends in Food Science and Technology, 17, p. 300-312