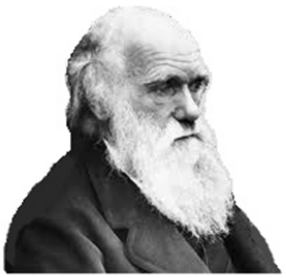
Available online at www.worldnewsnaturalsciences.com



World News of Natural Sciences

An International Scientific Journal

WNOFNS 17 (2018) 130-140 EISSN 2543-5426

Extraction of edible oil from the pulp of *Persea americana* (Mill) using cold process method

K. Nwaokobia[1,*], **R. O. Ogboru**[2] and **C. A. Idibie**[3]

[1]Department of Agricultural and Bio-Environmental Engineering Technology, Federal Polytechnic in Auchi, Edo State, Nigeria

[2]Research Coordinating Unit: Forestry Research Institute of Nigeria, P.M.B. 5054, Jericho Hills, Ibadan, Oyo state, Nigeria

[3]Department of Chemical Sciences, Edwin Clark University, P.M.B. 101, Kiagbodo, Delta State, Nigeria

*E-mail address: nwaokobia.kingsley@yahoo.com

*Tel: 08066755184

ABSTRACT

This paper investigated the extraction of edible oil from the pulp of avocado fruit by means of the cold process. Avocado pear fruit was collected washed, peeled, de-stoned, blended, and heated at 60 °C for 90 mins and then malaxed. No chemical solvent was introduced, as the blending of the pulp required only the addition of water. The process involves centrifuging the Avocado pulp via a laboratory centrifuge at 7000 rpm for 15 mins. While the solid pulp remained in the bottom, the liquid (oil-water mixture) floated on top. The mixture was dried for an hour using a heating mantle and then filtered using filter paper to remove the suspended pulp particles. A dark greenish brown oil was thus obtained with a yield of 6.3 %. The physicochemical properties of the oil in terms of acid value, saponification value, ester value, % FFA, % glycerine, specific density and moisture content were found to be 23 mg KOH/g oil, 199.7 mg KOH/g oil, 176.7 mg KOH/g oil, 11.5%, 9.66%, 1.19 g/L and 75%, respectively. This process is devoid of the use of any reagent and hence, is suitable for consumption. The process requires limited labour and low temperatures, thus its nutrients, flavour, and richness are safeguarded and the product retains its healthy properties

***Keywords*:** Avocado, *Persea americana*, pulp, edibile oil and cold press.

(Received 11 February 2018; Accepted 25 February 2018; Date of Publication 26 February 2018)

1. INTRODUCTION

Avocado (*Persea americana*), also called alligator pear, is a tree native to the Western Hemisphere from Mexico south to the Andean regions and Central America. It is now being cultivated in the subtropical and tropical areas such as East and West Africa respectively. Its fruits which have a yellow-green to purple skin are described as a berry with a thick, fleshy mesocarp surrounding a single large seed. It weighs 50 grams to 1 kilogram with the mesocarp (edible flesh) contributing 50-80% and the seed 10 to 25% of its total weight. Its trees are evergreen and flowers in spring from the previous summer growth. There are three types; the Mexican which thrive in Mediterranean climate, Guatemalan in high altitude tropics and the West Indian in humid and tropical climate. It is largely cultivated to some degree in the tropical rainforest and savannah belts of Nigeria. However, 15% of the avocado which is a potential source of oil is discarded as waste [4, 14-23].

It contains vitamins A, B, C, E and other nutrients like magnesium, potassium, iron, niacin and folacin. Vitamin A, C & E help in protecting the body against eye cataract, cancer due to cell mutation as a result of its anti-oxidant activities, heart disease due to cholesterol [5] and thus slowing down the aging process. Its high fibre content helps in lowering the effect of hypertension, obesity and cardiovascular disease [5].

It also contains monounsaturated fats (70% of its fat) which makes it highly recommended for infants as it is beneficial for their development [11].

Avocado oil (*Persea americana)* which is dark green in colour is extracted from the pulp of the fruit of the avocado tree. It is used in the production of cosmetics and healthcare products such as soaps, creams, hair products and lubricants. Traditionally, the commercial process for avocado oil extraction uses hard, mature whole fruit (no removal of the seed) and involves drying, mechanical pressing at high temperatures and oil extraction with an organic solvent. The use of solvents in a commercial scale has been questioned because of air pollution concerns. In addition, the removal of the solvent from the oil cannot be 100 percent guaranteed and it may affect the oil quality. The most recent technique involves ripening which allows softening of the fruit previous to mechanical pressing and centrifuging the mixture to separate the oil from the water and solids. The latter method (centrifugation) results in oil that is suitable for consumption. India and China are the principal producers and suppliers of avocado oil to international markets such as The United States, Germany and Malaysia.

In Nigeria there are various types of vegetable oils obtained from palm kernels, coconut, cotton seed, olive seed and soya bean seed etc. They are usually extracted from seeds, fruits, kernels, and nuts either by the use of solvents or mechanical press. The oils from fruit and seeds are of great importance because of their functions and uses to mankind. Fats and oils act as insulators to the body, protective layer for the internal organs such as heart and are sources of energy to the body [12].

Over the years, the methods of extraction of oil from avocado pear such as solvent extraction have resulted in oil that was not suitable for consumption. The centrifugation process which is expensive is currently used to extract edible oil from avocado that is comparable to olive and palm oils. This research is therefore geared towards providing further information about the quality, quantity and properties of the oil that will enable/enhance its production especially in Nigeria and West Africa. The main object of this research work is to extract oil from avocado pulp that is suitable for consumption using the cold extraction

process, determine the physical and chemical properties of the oil and as well as to determine the oil yield and finally characterize the oil in terms of usefulness and compare it to already set standard [6,8,9]

2. MATERIALS AND METHODS

2. 1. Raw Materials and Pulp Preparation

40 pieces of ripe avocado pear which were obtained from Oba market, Ring road, Benin-City, Edo State, Nigeria were sent to the Delta State University Central Laboratory, Abraka for extraction. The pre-extraction process follows the fruits being cleaned, peeled, de-stoned, blended, mixed, centrifuged and filtered. The extraction process was thus carried out using the centrifugation process (cold process) using 2260 g of pulp. Figure 1 shows the flowchart of the process. The sequence is as follows:

2. 2. The Pre-extraction Process

Fruit cleaning: This was done by washing with water and soap to remove dirt, leaves, twigs which can wear out the centrifuge and reduce its life span from 25 to 5 years.

Peel removal: This is also known as de-skinning and was done using a knife to peel off totally the outer skin. 100% of the skin was removed as this would affect the pigment composition and colour of the oil.

De-stoning: This was done using a knife to remove the inner seed.

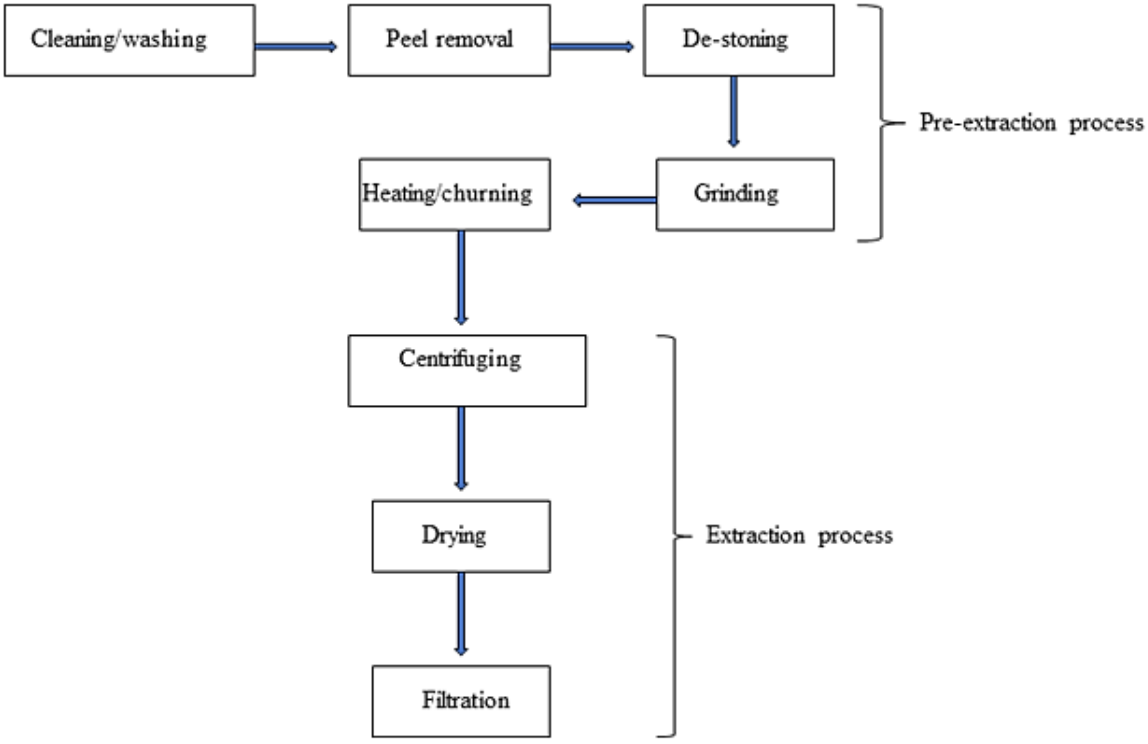


Figure 1. Flowchart of oil extraction process from avocado pear

Grinding: This was done using an electric blender to crush the large pieces of pulp with a small amount of water into a smooth paste. This was done to accelerate the release of oil from the vacuoles. Figure 2 shows the different stages of the avocado pre-extraction process.

(a)

(b)

(c)

Figure 2. Ripe avocado pear **(a)** after de-skinning and de-stoning **(b)** and Avocado pulp after blending **(c)**

Malaxing: This is a churning process and was done while heating the pulp paste in the water bath at 60 °C for 90 minutes. The smooth paste was continually mixed with a spatula to allow small oil droplets aggregate to form larger ones to increase oil yield.

2. 3. The Extraction Process

Centrifugation: The weight and volume of the pulp paste was obtained using a weighing balance and beaker respectively. The heated pulp paste was then put into the 6 test tubes of the 2 phase decanter centrifuge. It was then centrifuged at 7000 rpm for 15 mins at 40 °C.

This was done 13 times till all the pulp paste was centrifuged. The resultant centrifuged solid pulp was centrifuged again 6 times at another 7000 rpm for 30 mins at 40 °C, resulting into a very dry pulp. The centrifuged oil water mixture was weighed and the volume was taken [7].

Drying: The mixture was then subjected to heat at 105 °C for an hour until it reached a constant weight. This was done using a heating mantle.

Filtration: The oil left was then filtered using a filter paper and funnel and later centrifuge to remove any trace of unwanted or suspended particles. The final oil thus obtained was weighed and the volume was recorded to get its yield.

3. CHARACTERIZATION OF OILS

3. 1. Physical Analysis

Determination of moisture content: a known weight of the sample was taken and dried for an hour and a half at 105 °C. It was reweighed and cooled to a constant weight. The percentage of moisture was calculated as shown below:

$$\%\ moisture\ content = \frac{W_1 - W_2}{W_2} \times 100 \quad (1)$$

where: W_1 is the weight of sample before drying
W_2 is the weight of sample after drying

Density: This was determined using a density bottle. The density bottle was first cleaned and weighed, M_1. The bottle was then filled with boiled water at 25 °C and then weighed M_2. The water was poured out and the sample oil was put into it. The bottle and oil sample were weighed, M_3.

Melting point: A little amount of the oil sample was put inside test tubes, and the liquid oil was frozen to solid. The melting point is the temperature at which the solid oil changes back to liquid. This melting temperature was achieved using a thermometer.

3. 2. Chemical Analysis

Acid value number: The number expresses the quantity of potassium hydroxide in milligrams required to neutralize the free acids present in 1 g of the substance. It is a measure of hydrolytic rancidity and an indication about the edibility of the lipid. Here, 1g of the oil was weighed and put in a conical flask. 5ml of alcohol and 5ml of benzene were added to the oil in the flask. The contents were shaken to dissolve the free fatty acids. 3 drops of phenolphthalein were added to the mixture. The mixture was then titrated against 0.1 M KOH until pink colour appeared.

$$\text{Acid value} = \frac{X \times M \times 56.1}{Weight\ of\ sample} \quad (2)$$

where: X is the volume of KOH required to neutralize the oil solution.
M is the strength of KOH.

Iodine value: This expresses the quantity in grams of iodine absorbed per 100 g of lipid. It gives a measure of the average degree of unsaturation of a lipid. Here, 0.2 g of the oil was dissolved in 15 ml of CCl_4, and 25 ml of iodine monochloride solution added, corked, mixed and allowed to stand for 1hr in the dark. 20 ml of 10% KI solution and 150 ml of distilled water were added. The unreacted iodine was titrated with 0.1 M $Na_2S_2O_3$ using starch indicator to a blue colour. A blank titration was carried out in the same manner and the iodine value was calculated thus

$$\text{Iodine value} = \frac{\text{blank titre} - \text{sample titre} \times \text{molarity of } Na_2S_2O_3 \times 12.92}{Weight\ of\ sample} \quad (3)$$

Saponification value: This is a number that expresses the quantity of KOH in mg required to neutralize the free acids and saponifies the esters in 1g of the substance. It is a measure of the average molecular weight of the triacylglycerols in a sample. The process involves putting 1g of the oil into a conical flask, and then adding 50 ml of alcoholic KOH. To this is fixed a reflux condenser and the content is refluxed for one hour. Similarly, 50 ml of the alcoholic KOH (blank solution) is refluxed in a round bottom flask and then cooled after refluxing for one hour. 3 drops of phenolphthalein indicator were added to the hot solution. The two solutions were titrated against 0.1 M hydrochloric acid [10]. Saponification value was thus obtained by

$$\text{Saponification value} = \frac{56.1 \times Z \times M\ of\ HCl}{Weight\ of\ sample} \quad (4)$$

where: Y is the ml of HCl required by blank
X is the ml of HCl required by sample
Z = (Y-X) is the volume of HCl required to neutralize excess alkali
M is the strength of HCl

Ester Value: It expresses the quantity of KOH in mg required to react with glycerine after saponifying one gram of fat. It determined thus

$$\text{Ester Value} = \text{Saponification value} - \text{acid value} \quad (5)$$

$$\%\ \text{glycerine} = \text{ester value} \times 0.054664 \quad (6)$$

4. RESULTS AND DISCUSSION

4. 1. Results

Oil yield

Table 1. Oil yield of avocado

RUN	SOLVENT	YIELD
1	water	6.3%

Physical characteristics

Table 2. Physical characteristics of avocado oil

Solvent	Density	Specific gravity	Moisture content	Melting point	Colour
Water	1.19g/L	1.19	75%	15 °C	Dark greenish brown

Chemical characteristics

Table 3. Chemical characteristics of avocado oil

Acid value (ml/g)	Saponifiation value (ml/g)	Ester value (ml/g)	%free fatty acids	% glycerine
23	199.7	176.7	11.5	9.66

4. 2. Discussion

Oil yield

The yield of the oil was found to be lower than the standard oil content of between 10-20 % as shown in Table 1. This was likely due to the speed of the laboratory centrifuge which spun below the ideal speed (12000 rpm). This could have limited the amount of liquid separated from the pulp as the centrifugal force was not high enough. Another important factor that could have played out for the reduced oil yield is the type of cultivars available in the country. Despite these militating factors, an appreciable yield of 6.3 % was achieved.

Density/moisture content

The standard specific gravity of avocado oil is between 0.912-0.923 g/L [3]. The oil obtained from the experiment had a specific gravity of 1.19 g/L which was much higher than the ideal. This could be due to the presence of solid particles likely to have arisen from the insufficient centrifugal force during the spinning/ malaxing process of the pulp paste. The moisture content of the oil on the other hand was found to be quite high as 75 % moisture content was achieved.

Melting point

This is the temperature at which frozen solid oil changes back to liquid. The melting point of avocado was gotten to be 15 °C. The melting point of avocado oil is 10.5 °C. Melting

point is dependent on the length of the fatty acid and its degree of unsaturation. Due to its low melting point, it can be used in mayonnaise as salad oil.

Saponification value

From the result presented in Table 3, the saponification value of the oil was 199.7 ml/g. The value can be compared with shea butter oil (185 ml/g) and cotton seed oil (194 ml/g) but was, however, higher than that of native pear (25.9 ml/g). This shows that the oil has a long chain of free fatty acids. The range of value is useful in the soap and cosmetic industry as it would not require too much KOH to saponify the oil.

Acid value

It expresses the quantity of potassium hydroxide in milligrams required to neutralize the free acids present in 1g of the substance. It is a measure of hydrolytic rancidity and indication on the edibility of the lipid. It is therefore also expressed as the measure of oil rancidity which is the resistance of the oil to oxidative polymerization. According to *Harwood* [2], the acid value of crude avocado oil was 6.8ml/g which was much lower than 23ml/g obtained from this work. This could be due to the presence of some pulp particles that fermented in the oil-water mixture or oxidation during processing and storage [1].

% Free fatty acid (FFA) and glycerine

This is the percentage of free fatty acid in the oil. Result shows that % FFA obtained was 11.5 % which is in the range considered to be high for both crude and refined oil. This implies that the oil contains some acids of poor rancidity. Generally, FFA varies depending on oil type, season, region, harvesting methods, storage conditions, etc. However, the presence of heat, acids enzymes and bases is known to catalyse the hydrolysis of oil and thus could lead to increase in free fatty acids. The lower the free fatty acid, the more edible it is because high level of free fatty acid leads to high risk in the development of diabetes and cardiovascular diseases [13]. The % glycerine of the produced oil was found to be 9.66.

Ester value

The ester value which expresses the quantity of KOH in mg required to react with glycerine after saponifying one gram of fat, is the difference between the acid value and the saponification value of the oil. The ester value of the avocado obtained was 176.7 ml/g. The ester value of avocado oil was 172.8 ml/g, which is closely related to the experimental value. It is lower than rubber seed oil (191.93 ml/g) and comparable to castor oil (174.09 ml/g).

5. CONCLUSION

The cold process that involves both the pre-extraction and extraction procedures of oil from avocado pear is promising because the process is devoid of the use of any reagent and thus making it suitable for consumption. Suffice to emphasize that the process requires limited labour and low temperatures which safeguard its nutrients, flavour, and richness and thus retaining healthy properties. Characterization of the oil showed that the physicochemical properties in terms of acid value, saponification value, ester value, % FFA, % glycerine,

specific density and moisture content were 23 mg KOH/g oil, 199.7 mg KOH/g oil, 176.7 mg KOH/g oil, 11.5%, 9.66%, 1.19 g/L and 75% respectively. While some of the values are within acceptable standard, few experienced some offshoots which will require the oil a bit of refinement to bring these parameters under acceptable standard.

Recommendation

Oil production from avocado pear via the cold process is found to be very promising. Currently this technology is not very popular and only found in few countries, and with the usefulness of the oil from avocado pear that is diverse, the following are recommended for the production of oil via the cold process particularly in Nigeria:

a) The Government should invest more in the agricultural sector and provide farmlands for large scale production of avocado varieties such as Fuerte, Hass.
b) Future research should be done on increasing the stability of its shelf life as it becomes unstable when exposed to sunlight due to its high chlorophyll content.
c) Increased research and development (R&D) on avocado in Nigeria despite its prior production in the country.

References

[1] Guillen M. D and Cabo N (2002). Fourier transform infrared spectra data versus peroxide and anisidine values to determine oxidative stability of edible oils. *Food Chemistry* 77: 503–10.

[2] Harwood L., Laurence M., Moody H. and Christopher J. (13 Jun 2013). Experimental organic chemistry: Principles and Practice (Illustrated ed.). Wiley-Blackwell. pp. 122–125.

[3] Hodgman, C.D and N.A. Lange (1924). Handbook of Chemistry and Physics. Cleveland: Chemical Rubber *Co*. 312-313

[4] John M. Graham and D. Rickwood (1997). Sub cellular Fractionation: A Practical Approach. Oxford University Press, p. 234

[5] Rizvi S, Raza, S. T, Ahmed, F, Ahmad, A, Abbas, S and Mahdi, F (2014). The Role of Vitamin E in Human Health and Some Diseases. *Sultan Qaboos Univiversity Medical Journal* 14(2): 157–165.

[6] Lawrence, B. (2000). Essential Oils: From Agriculture to Chemistry. NAHA's World of Aromatherapy III Conference Proceedings, pp. 8–26.

[7] Ogunwusi A.A. and Ibrahim H.D (2016). Economic Significance of Avocado Pear in Nigeria. *Developing country studies* 6(3): 1-10

[8] Susan R. Mikkelsen & Eduardo Cortón. Bioanalytical Chemistry, Ch. 13. Centrifugation Methods. John Wiley & Sons, Mar 4, 2004, pp. 247-267.

[9] T.P. Human 2007. Oil as a by-product of the avocado. South Afr. Avocado Grow Assoc. Yearbook 10: 159-62.

[10] Tanaka, Y., Takeshi, O (2004). Extraction of Phospholipids from salmon roe with supercritical carbon dioxide and an entrainer. *Journal of Oleo Science* 53 (9): 417–424. doi:10.5650/jos.53.417

[11] Werman, M. J. and Neeman, I. 1986. Oxidatice Stability of Avocado Oil. *Journal of the American Oil Chemists Society* 63, No 3. 355-360.

[12] Williams, D. (1996). The Chemistry of Essential Oils. Dorset, England: Micelle Press.

[13] Zhi-Hua L, Pei M, Wan L, Hui X, Lu H, Si-Wei L, Xin Z, and Jian-Cheng T (2014). Association between serum free fatty acid levels and possible related factors in patients with type 2 diabetes mellitus and acute myocardial infarction. *BMC Cardiovascular Disorder*, 14: 159.

[14] Vishwa N. Verma, Application of atomic absorption spectroscopy to food sciences (A study on *Persea americana* Mill – Avocado). *World Scientific News* 49(2) (2016) 104-116

[15] Tsegay Hiwot, Determination of oil and biodiesel content, physicochemical properties of the oil extracted from avocado seed (*Persea americana*) grown in Wonago and Dilla (gedeo zone), southern Ethiopia. *World Scientific News* 58 (2016) 133-147

[16] E.H. Swisher, *Journal of the American Oil Chemists' Society* November 1988, Volume 65, Issue 11, pp 1704–1713

[17] Ana Carla Marques Pinheiro; Eduardo Valério de Barros Vilas Boas; Lucas Carvalho e Silva; Alessandra de Paiva Alves; Marcelo La Selva; Adimilson Bosco Chitarra. Quality of fresh-cut avocado (*Persea americana* Mill.) stored under different temperatures. *Ciênc. agrotec.* vol. 33, no. 4, Lavras July/Aug. 2009. http://dx.doi.org/10.1590/S1413-70542009000400021

[18] Mark S Hoddle, Sueo Nakahara, Phil A Phillips. Foreign exploration for *Scirtothrips perseae* Nakahara (Thysanoptera: Thripidae) and associated natural enemies on avocado (*Persea americana* Miller). *Biological Control* Volume 24, Issue 3, July 2002, Pages 251-26

[19] Kate IE, Lucky OO. Biochemical evaluation of the traditional uses of the seeds of *Persea americana* Mill., (Family: *Lauraceae*). *World J Med Sci.* 2009;4:143–6

[20] Luiz Gustavo Lacerda, Tiago André Denck Colman, Tabata Bauab, Marco Aurélio da Silva Carvalho Filho, Ivo Mottin Demiate, Eliane Carvalho de Vasconcelos, Egon Schnitzle. Thermal, structural and rheological properties of starch from avocado seeds (*Persea americana*, Miller) modified with standard sodium hypochlorite solutions. *Journal of Thermal Analysis and Calorimetry* February 2014, Volume 115, Issue 2, pp 1893–1899

[21] Philip F. Builders, Abigail Nnurum, Chukwuemaka C. Mbah, Anthony A. Attama and Rahul Manek. The physicochemical and binder properties of starch from *Persea americana* Miller (Lauraceae). *Starch – Stärke* Volume 62, Issue 6, June 2010, Pages 309–320

[22] J. J. Pérez-Arévalo, A. J. Callejón-Ferre, B. Velázquez-Martí, M. D. Suárez-Medina, Prediction models based on higher heating value from the elemental analysis of neem,

mango, avocado, banana, and carob trees in Guayas (Ecuador), *Journal of Renewable and Sustainable Energy*, 2015, 7, 5, 053122

[23] Luiz Gustavo Lacerda, Tiago André Denck Colman, Tabata Bauab, Marco Aurélio da Silva Carvalho Filho, Ivo Mottin Demiate, Eliane Carvalho de Vasconcelos, Egon Schnitzler, Thermal, structural and rheological properties of starch from avocado seeds (*Persea americana*, Miller) modified with standard sodium hypochlorite solutions, *Journal of Thermal Analysis and Calorimetry*, 2014, 115, 2, 1893