ISSN : 0974 - 7508 Volume 10 Issue 1

Natural Products

An Indian Journal

Full Paper

NPAIJ, 10(1), 2014 [27-29]

Comparative evaluation of caffeine extraction in waste tea as a potential low-cost source relative to dry tea in different solvents

Asma Amoozegaran*[1], Mohammad Javaherian[2]

[1]Department of Chemistry, Omidieh Branch, Islamic Azad University, Omhdieh, (IRAN)

[2]Faculty of Science, ShahidChamran University, Ahvaz, (IRAN)

E-mail: asma_am_66@yahoo.com

ABSTRACT

In this study, waste tea andfresh teawere extracted with different solvents andemploying different extraction conditions in order toobtain maximum amounts of extracted caffeine. The lowest extraction yields, for both fresh and waste tea were obtained with water and highest extraction yield of caffeine was achieved with chloroform.

KEYWORDS

Caffeine;
Waste tea;
Fresh tea;
Extraxteion.

INTRODUCTION

Tea (*Camellia sinensis*) is one of the most popular beverages in the world because of its sensory properties, stimulating effects and potential health benefits[1-3]. To understand the mechanisms behind these effects, a great deal of scientific effort has been made to isolate and identify active components in tea[4]. One of them is caffeine, which has attracted much scientific and public attention during the past years. The caffeine content of tea leaves varies with tea type, but the normal range goes from 2–5% (dry weight, w/w) together with small amounts of theobromine[5]. Caffeine is chemically 1,3,7-trimethylxanthine ($C_8H_{10}N_4O_2$), which is an alkaloid found in tea, guarana, kola nuts, coffee, cocoa beans and other plants[6]. Caffeine acts as a stimulant for the heart, respiratory and the central nervous system, and is a vasodilator (relaxes the blood vessels) as well as a diuretic (increases urination)[6]. Caffeine has been extensively studied for its physiological effects on human health in terms of behaviour/mood and as a diuretic and a weak bronchodilator[7].

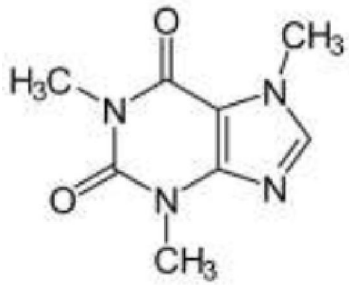

Figure 1 : Structure of caffeine

Green tea active ingredients, mainly catechins andcaffeine, are usually isolated by extraction with organicsolvents, where extraction conditions (tea and solventtype, temperature, time, pH, ratio of solvent to material.)variously influence the extraction efficiency andquality of obtained extracts. Additionally, duringextraction the epimerization of major catechins canoccur[8-10]. In order to obtain caffeine-free products of green tea, decaffeination processesare nowadays used and these include extraction withmethylene chloride[11], ethyl acetate or supercritical carbon dioxide[12-13]. The quality of decaffeinated material, obtainedwith these solvents, varies in the amount of isolated

Full Paper

caffeine,remaining catechins and solvent residue. Anadvantage of high-pressure extraction of green tea withCO_2 is that a decaffeinated material with almost thesame amount of catechins as the starting material canbe obtained.

Extraction of caffeine from green tea leaves has been reported[14-23]. However, no report has been done on the use of waste tea for theextraction of caffeine. The purpose of thiswork was to comparative evaluatingwaste tea relative to fresh tealeaves for the extraction of caffeine.

EXPRIMENTALS

Plant materials and chemicals

Whole dry tea leaves (*Camellia sinensis*) (Place of origin: Ahvaz, Iran) were purchased from a local market. Methanol, ethyl acetate, dichloromethaneand chloroform used in the experimental workwere all of analytical reagent grade chemicals. Caffeine and allother chemicals for analysis of tea caffeine used were all of analyticalreagent grade chemicals.

Method

Four hundred milliliters of distilled water were poured over 40 g of dry tea leaves or waste tea and 10 g sodium carbonate in a reflux flask and stirred and refluxed without maintaining constant temperature. Extract solution was subsequently cooled during this time and then transferred to a decanter funnel and extracted by dichloromethane or chloroform. The extraction mixture was then filtered (0.45 μm) and directly evaporated to dryness and concentration of dry matter determined as an average of caffeine from triple trials. This extraction was repeated by ethyl acetate, dichloromethane and chloroform instead of water as a solvent. Structural elucidation of the compound was performed using their and melting point and IR data in comparison with those reported in the literature.

RESULTS AND DISCUSSION

A waste tea andfresh teawere extracted with different solvents andemploying different extraction conditions in order toobtain maximum amounts of extracted caffeine. By adjusting theextraction parameters, solvent, extraction temperature and time, teaextracts with approx. TABLE 1 shows caffeine contentin dry and waste teaextracts obtained with different solvents at constant temperature. Extraction yields also shows in figure 2. The lowest extraction yields, for both fresh and waste tea wereobtained with water and highest extraction yield of caffeine was achieved with chloroform.It can be seen that the extraction yields is in the range 0.1–1.67 %.regarding to green chemistry literature,although the level of the obtained caffeine along with dichloromethane and chloroform is significant,these solvent cannot be confirmed as they are toxic having effects on the extracted caffeine and naturally cannot be used safely in medication.

TABELE 1 : g caffeine extracted from 40 g dry tea leaves and waste tea in different solvents

	Fresh tea	Waste tea
water	0.13	0.04
Dicholoromethane	0.46	0.15
Chloroform	0.63	0.34
Ethyl acetate	0.42	0.13

In the end it can be concluded although caffeine from tea waste is negligible, but regarding to the importance of caffeine in the cosmetics industry, healthcare and pharmaceuticals, It's quite conceivable that tea waste replaced to fresh tea for caffeine extractions.

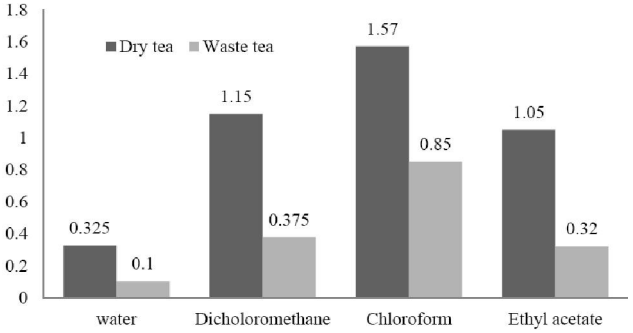

Figure 2 : The effect of different solvents on the extraction yields of caffeine

REFERENCES

[1] G.C.Yen, H.Y.Chen; Antioxidant activity of various tea extracts in relation to their antimutagenicity. Journal of Agricultural and Food Chemistry, **43**, 27–32 **(1995)**.

[2] A.G.Paschka, R.Butler, C.Y.Young; Induction of

apoptosis in prostate cancer cell lines by the green tea component, epigallocatechin-3-gallate. Cancer Letters, **130**, 1–7 **(1998)**.

[3] M.Shiraki, Y.Hara, T.Osawa, H.Kumon, T.Nakauama, S.Kawakishi; Antioxidative and antimutagenic effects of theaflavins from black tea. Mutation Research, **323**, 29–34 **(1994)**.

[4] H.Horie, K.Kohata; Analysis of tea components by high-performance liquid chromatography and high-performance capillary electrophoresis. Journal of Chromatography A, **881**, 425–438 **(2000)**.

[5] W.R.Harlan, S.M.Moseley, O.Kirk; Encyclopedia of Chemical Technology. John Wiley & Sons, New York, **(1995)**.

[6] N.M.Najafia, A.S.Hamidb, R.K.Afshina; Determination of caffeine in black tea leaves by Fourier transform infrared spectrometry using multiple linear regression. Microchemical Journal, **75**, 151–158 **(2003)**.

[7] I.Hindmarsh, P.T.Quinlan, K.L.Moore, C.Parkin; The effects of black tea and other beverages on aspects of cognition and psychomotor performance. Psychopharmacology, **139**, 230–238 **(1998)**.

[8] Y.Komatsu, S.Suematsu, Y.Hisanobu, H.Saigo, R.Matsuda, K.Hara; Studies on preservation of constituents in canned drinks. 2. Effects of pH and temperature on reaction-kinetics of catechins in green tea infusion. Bioscience Biotechnology and Biochemistry, **57(6)**, 907–910 **(1993)**.

[9] Y.Yoshida, M.Kiso, T.Goto; Efficiency of the extraction of catechins from green tea. Food Chemistry, **67(4)**, 429–433 **(1999)**.

[10] H.Wang, K.Helliwell; Epimerisation of catechins in green tea infusions. Food Chemistry, **70**, 337–344 **(2000)**.

[11] M.Hartmann, F.Baumberger; Good reasons to drink tea: the healthy components are not extracted during decaffeination. Chimia, **54(5)**, 325–326 **(2000)**.

[12] C.J.Chang, K.L.Chiu, Y.L.Chen, C.Y.Chang; Separation of catechins from green tea using carbon dioxide extraction. Food Chemistry, **68**, 109–113 **(2000)**.

[13] E.Lack, H.Seidlitz; Commercial scale decaffeination of coffee and tea using supercritical CO2. In M.B.King., T.R.Bott, (Eds); Blacky extraction of natural products using near-critical solvents. Academic & Professional, **(1992)**.

[14] A.L.Dawidowicz, D.Wianowska; PLE in the analysis of plant compounds Part I. The application of PLE for HPLC analysis of caffeine in green tea leaves. Journal of Pharmaceutical and Biomedical Analysis, **37**, 1155–1159 **(2005)**.

[15] P.Li, Y.H.Wang, R.Y.Ma, X.L.Zhang; Separation of tea polyphenol from Green Tea Leaves by a combined CATUFM-adsorption resin process. Journal of Food Engineering, **67**, 253–260 **(2005)**.

[16] P.U.Amra, S.Mojca, K.Zeljko, W.Bernd, O.Frank, G.Sabine; Extraction of active ingredients from green tea (Camellia sinensis): extraction efficiency of major catechins and caffeine. Food Chemistry, **96**, 597–605 **(2006)**.

[17] H.L.Liang, Y.Liang, J.J.Dong, J.L.Lu, H.R.Xu, H.Wang; Decaffeination of fresh green tea leaf (Camellia sinensis) by hot water treatment. Food Chemistry, **101**, 1451–1456 **(2007)**.

[18] X.J.Pan, G.G.Niu, H.Z.Liu; Microwave-assisted extraction of tea polyphenols and tea caffeine from green tea leaves. Chemical Engineering and Processing, **42**, 129–133 **(2003)**.

[19] H.S.Park, H.K.Choi, S.J.Lee, K.W.Park, S.G.Choic, K.H.Kima; Effect of mass transfer on the removal of caffeine from green tea by supercritical carbon dioxide. The Journal of Supercritical Fluids, **42**, 205–211 **(2007)**.

[20] H.Horie, A.Nesumi, T.Ujihara, K.Kohata; Rapid determination of caffeine in tea leaves. Journal of Chromatography A, **942**, 271–273 **(2002)**.

[21] S.P.Hyong, G.I.Nam, H.K.Kyoung; Response surface analysis of caffeine and chlorophyll extraction in supercritical decaffeination of green tea. Journal of Biotechnology, in press (doi:10.1016/j.jbiotec.2008.07.1112), **(2008)**.

[22] W.J.Kim, J.D.Kim, K.J.Kim, S.G.Oh, Y.W.Lee; Selective caffeine removal from green tea using supercritical carbon dioxide extraction. Journal of Food Engineering, in press (doi:10.1016/j.jfoodeng.2008.05.018), **(2008)**.

[23] A.Senol, A.Aydin; Solid–liquid extraction of caffeine from tea waste using battery type extractor: process optimization. Journal of Food Engineering, **75**, 565–573 **(2006)**.