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Is The Paper Tea Bags Chemically Contaminated?

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ABSTRACT

Aims: This study aimed to identify the risks of using three brands of the most Egyptian consumers' preferred black tea. Epichlorohydrin (ECH), its metabolite3-monochloropropane-1,2 dial (3-MCPD), and some , were analyzed in the infusions.

Methods: Tea infusion was prepared by adding 100 ml of boiling deionized water in fine bone china cups to one bag of the three studied brands, and steeped for 2, 6, and 10 minutes. The effect of adding table sugar (3 or 6 g per cup), as well as the effect of rinsing the bag prior to preparing the teadrink on ECH and 3-MCPD content were estimated. ECH and 3-MCPD were determined using HPGC, while the heavy metals were detected by ICP-MS. The data were statistically analyzed.

Results: The results revealed that, the levels of ECH in all of the teabag infusions of tested brands after the three studied steeping times ranged between 1.68 to 11.40 µg/L. Adding sugar decreased the concentration of ECH in the infusions by 13-20%. Because ECH is easily dissolved in water at room temperature, rinsing the teabag perior preparing the drink removed more than 93% of its ECH content, also empting the tea particles from the bag significantly reduced the ECH concentration in the infusion. Assuming an adult person consumes one litter of tea drink a day, therefore its ECH intake is in the safe levels according to the WHO (2017) when the steeping time 2 min for all studied brands. We recommended to rinse the tea bags or empting the tea particles from the bag before preparing the infusions.

The 3-MCPD was not detected in tea infusions of brand A, while of brand C contained the highest levels of 3-MCPD and these levels increased by increasing steeping time. Fortunately, the concentrations of toxic heavy metals Al, Pb, and Cd were too low in infused samples compared to established guidelines of drinking water (WHO, 2007).

Keywords: Black tea, tea bags, Epichlorohydrin (ECH), metabolite3-monochloropropane-1,2 dial (3-MCPD), heavy metals (Aluminum, Lead, and Cadmium).

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INTRODUCTION

Tea has been one of the most popular simulating beverages after water, with an

estimated amount of 18 -20 billion teacups are consumed daily worldwide and annually

more than 6.6 billon Kg (Statista, 2020). It has a more significant role as a healthy

drink and a source of some essential phytochemicals with antioxidant properties

(Soni et al., 2015). The bioactive components in tea, such as polyphenols,

polysaccharides, polypeptides, pigments, and alkaloids, are the main contributors to its

health functions(Schwalfenberg et al., 2013; Yadav et al.,2020; Shang et al., 2021).

Many studies have proved that tea has some beneficial effects on human health such as

Prevention from Parkinson’s disease, cardiovascular disease, cancer, Immune

disorders, and decrease blood cholesterol levels (Shekoohiyan et al., 2012;Sanlier et

al., 2018; Rasheed, 2019).

Tea is considered to be one of the main strategic foodstuff commodities to Egyptians.

It is a deeply ingrained part of Egyptian culture to drink tea with meals as well as

between meals. Tea in Egypt has such widespread popularity because it is the cheapest

beverage after water. In rural areas, it is a substitute for fruits and is served to guests as

a welcome drink. According to FAO database (2005), Egypt spends about 3 billion

pounds a year for the tea and consume 100 tons of tea annually, and per capita consumption rate range between 3 and 5 cups per day, Egypt ranks fifth globally in the

consumption of tea. The annual per capita consumption of tea in Egypt is about 1,01

Kg (Statista, 2020).

The use of tea bags was not common until the WWII. Nowadays, tea bags are widely available and in recent years have become an increasingly common choice for consumers. Tea bags are easy to brew, easy to get rid of after brewing, save time and require no real thought or effort. Easy to brew is the biggest advantage of tea bags and the primary reason they are so popular (Yadav et al., 2017).

There are different types of teabags, paper, plastic, and silk. The most popular in Egypt markets are the paper teabags. Some tea bags are treated with epichlorohydrin (ECH), to improve its wet strength. The US EPA (1997) has listed ECH as a probable human carcinogen based on animal studies and allow up to 20 ppb (20 µg/liter)in drinking water, while the WHO (2017) approved 0.14 µg / kg of body weight as TDI (tolerable daily intake), for 60 Kg adult that is 8.4µg / day.

When ECH comes into contact with water it hydrolyzed to a chemical called 3-MCPD, a known cancer causing agent, (Göen et al., 2018),and its hydrolysis is accelerated in the presence of heat (von Pringer, 1980).

Pesticide residues, and heavy metals are the major chemical contaminants found in tea leaves (Hayacibara et al., 2004; The Tea Council, 2004, Li et al., 2014; Lu et al., 2015), such contaminants can be readily accumulated and are potentially carcinogenic, and associated with some diseases. Tea plant was found to accumulate Al up to 6866 mg/kg in old leaves, while in young leaves the concentration of Al was ~380 mg/kg (Carr et al., 2003). Also, many heavy metals such as mercury, lead, arsenic, and cadmium have been detected in tea leaves (Han et al., 2006; Wang et al., 2008; Shekoohiyan et al., 2012; Abd El-Aty et al., 2014).

Because tea is one of the most popular beverages and used all over the world, therefore, tea infusions can potentially increase the level of these heavy metals in humans (The Tea Council, 2004). And because of the widespread and increasingly prevalent usage of tea bags by consumers, therefore the aim of this study was to determine of some heavy metals and ECH in three brands of the most consumers' preferred black tea bags that widely sold in Alexandria markets, Egypt. Also, this study aimed to determine the effect of steeping time, adding sugar to the infusions, and other preparation techniques on the levels of ECH,3-MCPD, aluminum, lead, and cadmium in tea infusions when tea bags are used in laboratory experiments in a similar manner as a consumer.

MATERIAL AND METHODS

Sampling

A total of 30 samples of 3 different brands of black tea bags (10, each) were randomly collected from different supermarkets located in Alexandria city, Egypt. Samples are assigned as A, B, and C. The weights of tea bags were found to be 2.15, 2.26, and 2.20 g for A, and C, respectively, while the weight of empty bags were 0.19, 0,19 and 0.25 g for A, B, and C, respectively.

Tea infusions from different tea samples were prepared by pouring 100 ml of boiling deionized water over one bag of each tea bag brand. The resulting infusion was stirred with a glass rod for about 1 min to ensure proper wetting and steeped for 2, 6, and 10 min.

For studying the effect of adding sucrose on the release of ECH and 3-MCPD, 3 or 6 g of table sugar was added to prepared infusions with one tea bag from each brand, as well as the effect of empting the tea leaves from the bag before use. Also, the tea bags were rinsed under running water for 1 min before preparing the tea infusions to study the effect of rinsing the bags immediately before using on the released ECH.

Chemical Materials

Analytical grade standards for Epichlorohydrin (ECH) (1-chloro-2, 3-epoxypropane) and 3-monochloropropane-1,2-diol (3-MCPD) were obtained from Merck (USA) with a purity of 99%, while Certified HPLC-grades of dichloromethane and methanol, and nitric acid (65%) were purchased from Aldrich Company (Germany). Ultra-pure deionized water of 15 M cm resistivity and pH 7 was obtained from a water purification system (PURELAB Option-R, ELGA, UK) and used throughout this study. The stock of certified multi-elements standard (1000 mg/L) was obtained from J.B. Baker Inc. (Phillipsburg, NJ, USA) and used to prepare the working solutions. All other chemicals used in this study were of the highest grade available.

Determination of ECH and 3-MCPD

ECH and 3-MCPD were estimated in the studied tea infusions according to the method of Cai and Zou (2010) with slight modifications. When the solution reached room temperature, ECH was extracted with 3x10 ml of dichloromethane in the presence of 10 g NaCl by using a separator funnel. The organic layer was separated and transferred to a clean flask and subjected to rotary evaporation to evaporate it to near dryness. The residues were quantitatively transferred to 2 ml clean vial, completed to 1 ml with dichloromethane, and then subjected for analysis by gas chromatography

(Model GC 450, Varian Inc., the Netherlands) with a flame ionization detector (FID), split/split less injector and fused silica DB-5 and DB-1capillary columns (30 m x 0.25 mm i.d and 0.25 µm film thickness) for ECH and 3-MCPD, respectively.

In the case of ECH, the temperature inlet was 220ºC, while the oven conditions included an initial temperature of 60 ºC, held for 3 min, 30 ºC/min ramped to 120 ºC, holds for 2 min, followed by 20ºC/min to 180 ºC, held for 20 min and then by 15 ºC/min ramped to 220 ºC. In the case of 3-MCPD, the temperature inlet was 190 ºC, while the oven conditions included an initial temperature of 40 ºC, held for 3 min, 25ºC/min ramped to 80 ºC, hold for 2 min, followed by 30 ºC/min to 190ºC, held for 20 min and then by 15 ºC/min ramped to 220 ºC. Nitrogen was used as a carrier gas at a flow rate of 1 ml/min. Retention times (Rt) were used for positive identification.

Calibration experiments were carried out using series concentrations either of ECH or 3-MCPD ranging from 0.10 to 2.0ng/ml and calibration standards prepared in methylene chloride from the stock solutions (1000 µg/ml in methanol). The amount of ECH or 3-MCPD in each sample was thus calculated based on the slope of the standard curve.

Recovery tests

The samples utilized for the recovery studies were previously analyzed and did not contain residues either of ECH or 3-MCPD. Recovery was carried out at three fortification levels (0.50, 1.0, and 1.50ng/ml) by adding an appropriate volume of the standard solution to tea-free samples, extracted, and then analyzed as previously described. The absolute recovery and precision of the method (expressed as the relative standard deviation, RSD) were calculated and found to be ranged from 96 to 106% and 2 to 6%, respectively. The limits of detection were 0.08 and 0.11 µg/l, while the limits of quantitation were 0.26 and 3.05 µg/l, for ECH and 3-MCPD, respectively.

Determination of heavy metals

Metals (Al, Pb, and Cd) were analyzed in the infusions by the inductively coupled plasma optic emission spectrometry (ICP-OES EOP spectroacros, Model Varian Vista-MPX, USA) according to the method of US EPA (2004). The operating conditions were adjusted according to the standard guidelines of the manufacture. Analytical calibration standards were prepared directly from the certified metal standard solution (1000 mg/l).

The detection limits were 0.10, 1.8, and 0.08µg kg^{-1}, for Al, Pb, and Cd, respectively, with percentages of recovery ranging from 93-110.

Statistical analysis

Data were calculated as mean, standard deviation (SD) and analyzed using analysis of variance technique (ANOVA). A probability of 0.05 or less was considered significant.

RESULTS AND DISCUSSION

Levels of ECH in infusions of empty bags

The data in Table (1) show the mean and standard deviation of ECH concentration found in the infusion prepared using empty bags of the three studied tea brands (A, B, and C). The steeping time was 10 min. These values are 4.82±0.1, 9.18±0.0, and 10.44 ±0.0 µg/L, for brands A, B, and C, respectively. Results revealed that the levels of ECH were significantly different in the bags of the tested brands.

Table 1. Levels of ECH (µg/L) in infusions of empty bags (steeped time 10 min)

Brand	ECH (µg/L)
A	4.82±0.10 [a]
B	9.18±0.0 [b]
C	10.44±0.0 [c]

Data are expressed as mean and SD (n=6).
The weight of empty bags were 0.19, 0,19 and 0.25 g for A, B, and C, respectively. Means followed by the same small letters within the column do not significantly different from each other (p≤ 0.05).
When calculating the ECH contents in one empty bag of the three studied brands,
they are 0.48 , 0.92, and 1,04µg / teabag, for brands A, B, and C, respectively.
According to the review of Zrinyi (2019), the US EPA assumed that each tea bag
contains about 0.1 µg of ECH. Therefore, the three studied brands are more
contaminated with ECH than this suggested level.

Levels of ECH (µg/L) in infusions of tea bags

As shown from the data in Table (2) the brand A has the lowest concentration of ECH, followed by B, and then C, and the differences are significant. The leaching of ECH in the tea drink increased significantly with the increase of the steeping time. For brand A the ECH levels are ranged from 1.68 to 4.94 µg/L, while they ranged from 2.99 to 9.31 µg/L for brand B, and from 3.22 to 11.40 µg/L for brand C, for steeping time 2 to 10 min, respectively.

Assuming, an adult person drink one liter of tea a day, then his ECH intake will be ranged from 1.68 to 3.22 µg/ day, when using either of the studied brands for only 2 min steeping time. Using the brand C for steeping time more than 6 min, the ECH intake will exceeded the tolerable daily intake (TDI) which is 0.14 µg/Kg/day, or (8.4 - 9.8 µg/ day for an adult weighing 60 - 70 Kg) according to the WHO (2004 , 2017).

Table 2. Levels of ECH (µg/L) in infusions of tea bags steeped for different times

Brand	2min	6 min	10 min
A	1.68±0.03^{Aa}	2.77±0.12^{Ba}	4.94±0. 02^{Ca}
B	2.29±0.31^{Ab}	4.52±0.29^{Bb}	9.31±0. 21^{Cb}
C	3.22±0.50 ^{Ac}	6.41±0.22^{Bb}	11.40±0.31^{Cc}

Data are expressed as mean and SD (n=6).

Means followed by the same small letters within each column (Brand) do not significantly different (p≤ 0.05).Means followed by the same capital letter within each raw (steeping time) do not significantly different (p≤ 0.05).

Effect of empting the tea from the bag

When empting the tea from the bag before preparing the tea drink, the ECH concentration found in the tea drink are illustrated in Table (3).

As shown from the data in Table (3), brand C has the highest ECH level, and it is more

than 7 times the levels in the drinks of A and B, and it exceeds the tolerable daily intake

(TDI) of ECH in drinking water (0.4 µg /liter), according to the WHO (2017).

However, empting the tea bags caused great reductions in the ECH content to 97.6%,

98.6%, and 91.6% for brands A, B, and C, respectively.

Table 3. Levels of ECH (µg/L) in tea drinks when empting the tea from the bag before preparing the tea drink. (Steeping time 10 min)

Brand	With bag	Without bag	% reduction
A	4.94±0. 02^{Aa}	0.12± 0.06^{Ba}	97.6
B	9.31±0. 21^{Ab}	0.13±0.10 ^{Ba}	98.6
C	11.40±0.31^{Ac}	0.96±0.15 ^{Bb}	91.6

Data are expressed as mean and SD (n=6).
Means followed by the same small letters within each column (Brand) do not significantly different (p≤
0.05).Means followed by the same capital letter within each raw do not significantly different (p≤ 0.05).

Effect of rinsing tea bags

It was found that when bags were rinsed first with distilled water for 1 min and then the tea bags steeped for 2 min, ECH significantly underwent removing by water as it was expected from the high water solubility of ECH. The concentrations of ECH in the tea infusions of A, B, and C brands after rinsing were 14 times lower than that infusion of non-rinsed bags (Table 4).

Table 4. Effect of rinsing tea bags for 1 min under running water before preparing the drink on ECH (mcg/ L) (steeping time=2min)

Brand	without rinsing	after rinsing	% of removing
A	1.68±0. 03^{Aa}	0.12±0.01^{Ba}	92.86
B	2.29±0.31^{Ab}	0.16±0.01^{Ba}	93.01
C	3.22±0.047^{Ac}	0.23±0.02^{Bb}	92.86

Data are expressed as mean and SD (n=6).
Means followed by the same small letters within each column (Brand) do not significantly different (p≤ 0.05).Means followed by the same capital letter within each raw (rinsing) do not significantly different (p≤ 0.05).

Effect of adding sugar

Data in Table (5) represent the effect of sucrose on the levels of ECH in infusions of tea bags steeped for 2 min. It was found that there were significant differences between the three tested brands and between using and non-using sucrose regarding the levels of ECH in tea fusions. Also, the data show that there were no significant differences between using 3 or 6 g of sucrose on the levels of ECH of tea infusions. When 3 or 6 g of sucrose was added to the infusions, the levels of ECH reduced by 13, 15 and 20% in case of tea bags for A, B, and C brands, respectively.

Table 5. Effect of sucrose on the levels of ECH (µg/l) in infusions of tea bags

(steeping time 2 min)

Brand	Without sugar	3 g sugar	6 g sugar
A	1.68±0. 03^{Ba}	1.46±0. 07^{Aa}	1.46±0. 12^{Aa}
B	2.29±0. 31^{Bb}	1.95±0. 02^{Ab}	1.95±0. 42^{Ab}
C	3.22±0. 47^{Ac}	2.59±0. 26^{Bc}	2.59±0. 31^{Bc}

Data are expressed as mean and SD (n=6).

Means followed by the same small letters within each column (Brand) do not significantly different (p≤ 0.05).Means followed by the same capital letter within each raw (sugar amount) do not significantly different (p≤ 0.05).

MCPD in tea infusions

ECH tends to be hydrolyzed in water at ambient temperature to form3-MCPD and the rate of hydrolysis increases 7-fold when the temperature is raised to 40 °C (von Pringer, 1980).

Table 6. Levels of 3-MCPD (µg/L) in infusions of tea bags steeped for different times

Brand	2 min	6 min	10 min
A	ND ^{Aa}	ND ^{Aa}	ND ^{Aa}
B	0.03±0.001^{Ab}	0.04±0.001^{Bb}	0.05±0.001^{Cb}
C	0.04±0.001^{Ab}	0.05±0.002^{ABb}	0.06±0.004^{Bb}

Data are expressed as mean and SD (n=6).

Means followed by the same small letters within each column do not significantly different from each other (p≤ 0.05). Means followed by the same capital letters within each raw do not significantly different from each other (p≤ 0.05).

Data in Table (6) illustrate that 3-MCPD was not detected in infusion of tea bags of brand A, while of brand C contained the highest levels and these levels increased by increasing steeping time.

In 2016, 3-MCPD was probed in selected paper products sold in Canadian and German markets, and its transfer from these products to beverages. These products included tea bags (Becalski, et al., 2016). The 3-MCPD was detected in most paper products with levels ranging from a few nanograms in tea bags to a few micrograms in white coffee filters. Also, it is found in leachate from paper cups at levels of about 16 ng/cup. Therefore, our results are lower than those of Becalski, et al., (2016), ourdetected3-MCPD content per (small) tea cup was only 3-6 ng/100 ml. Health Canada uses a TDI of 1.1 µg /kg of body weight, or 66 µg per day (Zrinyi, 2019).Therefore drinking a liter of teabag infusions per day is safe.

Heavy metals in teabag infusions

Aluminum (Al)

As shown from the data in Table (7), there are significant differences between the studied brands. A infusions had the lowest Al content, while the C infusions had the highest. Also, the infusion time in the case of brand A had no significant effect on Al content, while increasing the infusion time to more than 2 min caused significant leaching of Al in the cases of brands B and C. These results are lower than those of Fung et al. (2009) who found that tea brands released Al (0.70-5.93 mg/L) during a standard infusion period. In comparison to Provisional Tolerable Weekly Intake (PTWI) of 2 mg Al/ kg body weight (Joint FAO,WHO, 2011), it was concluded that tea made with these tea bags will not impose adverse human health impacts.

Table 7. Levels of Al (µg/L) in infusions of tea bags steeped for different times

Brand	2min	6 min	10 min
A	0.012 ± 0.001^{Aa}	0.013 ± 0.002^{Aa}	0.014 ± 0.002^{Aa}
B	0.019 ± 0.002^{Ab}	0.021 ± 0.002^{Bb}	$0.021\pm0.002b^{Bb}$
C	0.021 ± 0.004^{Ac}	0.024 ± 0.002^{Bc}	$0.027\pm0.\ 001^{Cc}$

Data are expressed as mean and SD (n=6).
Means followed by the same small letters within each column do not significantly different from each other (p≤ 0.05). Means followed by the same capital letters within each raw do not significantly different from each other (p≤ 0.05).

Lead (Pb)

Data presented in Table (8) illustrate that Pb concentrations of the tea infusions of brand C were significantly higher than those of brands A and B. The levels of Pb in infusions of all brands steeped for different times were 0.01 µg/L except infusions of tea bags of brand C, where the level was 0.02 µg/L.

Table 8. Levels of Pb (µg/l) in infusions of tea bags steeped for different times

Brand	2min	6 min	10 min
A	0.01 ± 0.001^{Aa}	0.01 ± 0.001^{Aa}	0.01 ± 0.001^{Aa}
B	0.01 ± 0.001^{Aa}	0.01 ± 0.001^{Aa}	0.01 ± 0.001^{Aa}
C	0.02 ± 0.004^{Ab}	0.02 ± 0.003^{Aa}	0.02 ± 0.003^{Aa}

Data are expressed as mean and SD (n=6).
Means followed by the same small letters within each column do not significantly different from each other (p≤ 0.05). Means followed by the same capital letters within each raw do not significantly different from each other (p≤ 0.05).

The obtained results showed that Pb concentration in examined tea samples was found to be negligible and they were below the maximum values set by theJoint FAO,WHO, (2011) guidelines. Soliman, (2016) founda minimum level of Pb (1.41 µg/g) in several commercially available brands of tea leaves in Egypt.

Cadmium (Cd)

The results of Cd in Table (9) illustrate that the levels of Cd in infusions of all the tested brands steeped for different times were 0.10 µg/L and steep time did not alter Cd levels.

Fortunately, the concentrations of toxic heavy metals Al, Pb, and Cd were too low in infused samples compared to established guidelines (FAO/WHO, 2011). Askari et al., 2020 found higher concentrations of Al, Pb and Cd in black tea infusions than our results. Their mean values were 70, 530, and 3 µg/l, for Al, Pb and Cd, respectively, which exceeded the WHO guidelines.

Table 9. Levels of Cd (µg/l) in infusions of tea bags steeped for different times

Brand	2 min	6 min	10 min
A	0.10 ± 0.001^{Aa}	0.10 ± 0.001^{Aa}	0.10 ± 0.001^{Aa}
B	0.10 ± 0.001^{Aa}	0.10 ± 0.001^{Aa}	0.10 ± 0.001^{Aa}
C	0.10 ± 0.001^{Aa}	0.10 ± 0.001^{Aa}	0.10 ± 0.001^{Aa}

Data are expressed as mean and SD (n=6).
Means followed by the same small letters within each column do not significantly different from each other (p≤ 0.05). Means followed by the same capital letters within each raw do not significantly different from each other (p≤ 0.05).

The results of the present study contradict some previous studies, which accuse tea bags as a source of high levels of heavy metals becausethey often contain older leaves and low-cost tea materials (Wong et al., 2003;Shu et al., 2003; Rashid et al., 2016), and old leaves considered as the major contributors to the higher heavy metal contents in bagged tea (Yemane et al., 2008;Karak et al., 2010; El-Saeidy,et al., 2017).

CONCLUSION

There is growing interest in components of the tea bags that may confer health problems with regular consumption. In this study, we have investigated the extraction of ECH and certain heavy metals of tea products as they would be consumed habitually by millions of individuals in Egypt every day. A comparison of the results of the current study with standard values indicated that all studied heavy metal contents were within standard ranges. These levels of such contaminants were below the limits of WHO and EU standards and do not produce risk in Alexandrian humans. But, unfortunately, some teabags brands sold in Alexandria local markets are chemically contaminated by epichlorohydrin, therefore we recommend to avoid prolonged steeping time to prevent more transfer of this chemical compound from teabags to the infusion. It can be concluded that consumers who prefer to use tea bags should rinse these bags before preparing the tea infusion, and do not increase the steeping time to more than 2 minutes. On the basis of the above findings, further researches are needed of a greater number of teabag samples to obtain deeper knowledge about their health hazards.

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الملخص العربي

هل أكياس الشاي الورقية ملوثة كيميائيا؟

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تهدف الدراسة معرفة هل أكياس الشاي الأسود لثلاثة الأنواع الأكثر تفضيلا للمستهلك المصري مصدراً للتوث الكيميائي، و ذلك عن طريق تقدير كل من مركب الإبي كلوروهيدرين ECH، و٣- أحادي كلورو ديول 3-MCPD

، و بعض المعادن الثقيلة (ألومينوم، رصاص، كادميوم)، في مشروب الشاي. تم إعداد المشروب بسكب ١٠٠ مل من الماء المقطر المغلي علي كيس واحد (وزن حبيبات الشاي ٢±٠،٠٣ جم) في كوب مصنوع من الصيني عالي الجودة و ترك الكيس لمدد ٢، و ٦، و ١٠ دقائق. تم دراسة تأثير اضافة سكر السكروز (٣ ، و ٦جم) / كوب ، و كذلك تأثير شطف الكيس بماء جاري لمدة دقيقة واحدة قبيل إعداد المشروب، أو تفريغ حبيبات الشاي من الكيس علي تسرب مركبي ECH، و 3-MCPD في المشروب. تم تقدير كل من مركبي 3-MCPD, ECH باستخدام التحليل الكروماتجرافي الغازيHPGC ، و تقدير المعادن الثقيلة باستخدام ICP-MS، تم معالجة النتائج إحصائياً.

اوضحت النتائج أن مستوي مركب ECH في مشروب الشاي المعد من الثلاثة أنواع موضع الدراسة للثلاثة أزمنة تراوح ما بين ١،٦٨ – ١١،٤ ميكروجرام / لتر مشروب. إضافة السكر أدي إلي خفض ١٣%- ٢٠% من الكمية المتسربة من ECH، و بسبب سرعة ذوبان ECH في الماء حتي علي درجة حرارة الغرفة فإن شطف الكيس بماء جاري لمدة دقيقة واحدة قبيل إعداد المشروب أدي إلي تخلص معنوي بلغ أكثر من ٩٣% من مركب ECH.

لم يتم اكتشاف مركب 3-MCPD في المشروب المعد من أكياس الشاي A ، و اكتشافه في النوع C عند زيادة بقاء الكيس في المشروب عن دقيقتين.لحسن الحظ، فإن تركيز المعادن الثقيلة منخفض جدا مقارنة بالمسموح بتواجده في مياه الشرب.

الكلمات الافتتاحية: الشاي الأسود، الإبي كلوروهيدرين ECH، ٣- أحادي كلورو ديول

3-MCPD، المعادن الثقيلة (ألومينوم، رصاص، كادميوم).