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Various preparation conditions of tea infusion: a worldwide questionnaire

Tea infusion

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Abstract

Purpose – There are many variations of brewing techniques which can impact both flavor and chemistry of the brew significantly. Therefore, the purpose of this study was to understand and identify the most common conditions used among a relatively large sample of worldwide tea consumers for preparing tea drinks.

Design/methodology/approach – An electronic questionnaire was formed via Google Drive[®] and distributed publicly online from 12 November 2014 to 9 January 2015. It contained 18 questions divided into sections. The valid answers received from 2,690 person were coded and statistically analyzed using SPSS 20.0 to calculate the frequencies, categorize the data into observed variables by using cross-tabulation and compare the observed data with the author expectations by using the chi-square test technique. Results were presented as (frequency; percent).

Findings – The results showed that a lot of tea-drinking respondents add sugar to their drink (2,242; 87.4 per cent). The great majority of respondents would drink their tea with additives (natural flavoring) (1,814; 70.7 per cent). Furthermore, there was a significant association between the number of tea drinkers and their gender and country of residence ($p < 0.05$), while the age of the respondents was not a significant factor affecting tea drinking. The same was observed about the association between number of people using additives and their gender, country of residence and age. Most of the participants thought that adding sugar would decrease tea's health benefits, while adding some natural flavoring would increase it.

Originality/value – These most common conditions used among tea consumers can guide further conducted researches on tea drink to have more impact on people's ways and understanding of different tea infusion preparations.

Keywords Additives, Questionnaire, Sugar, Tea infusion, Worldwide

Paper type Research paper



1. Introduction

Long ago, tea was probably only considered as a medicine, but then became popular as a beverage (Harbowy *et al.*, 1997). As tea migrated from its native home in China to other parts of the world, each new region embraced the simple drink and added its unique mark to it (Campbell, 1995).

There are many variations on brewing technique which can impact both flavor and chemistry of the brew significantly. However, the basic custom of brewing the dried tea leaves in hot water has been popularized and spread throughout most of the world (Harbowy *et al.*, 1997). This brewing method might be based on the most popular myth depicting tea's early discovery; while one of China's first emperors was boiling water for purification, a leaf from a nearby tea tree fluttered into the pot. When the emperor tasted the decoction he loved it, and ordered planting and gathering tea leaves (Campbell, 1995). The distinctive color, flavor and aroma of tea result from chemical changes that occur during leaf processing (Balentine *et al.*, 1997), which include one or more of the following steps: withering, rolling, oxidation (or fermentation), drying and grading (Martin, 2007).

The fresh tea leaves contain a wide variety of compounds, caffeine (approximately 3.5 per cent); theobromine (0.15-0.2 per cent); theophylline (0.02-0.04 per cent), among other methylxanthines; lignin (6.5 per cent); organic acids (1.5 per cent); chlorophyll (0.5 per cent); theanine (4 per cent); free amino acids (1-5.5 per cent); and numerous flavor compounds. Other components also exist, including carbohydrate, alkaloids, minerals, vitamins, enzymes and polyphenols, which are the main constituents of tea leaves (Senanayake, 2013; Li *et al.*, 2013).

Catechins are the most important polyphenols in tea, and their high levels may render the tea bitter and affect its astringency (Alhafez *et al.*, 2014), but their bioavailability from tea is believed to be relatively poor. In humans, maximum catechin plasma concentrations of up to 1-2 $\mu\text{mol/L}$ are achieved between 1 and 2 h after consumption. It was suggested that adding sucrose (table sugar) and ascorbic acid to green tea infusion may improve catechin bioavailability by enhancing bioaccessibility and intestinal uptake from tea (Peters *et al.*, 2010).

During the past few years, the interest on polyphenols and other antioxidants activity compounds has increased among many researchers as well as food consumers. Polyphenols provide health benefits by several mechanisms, for example by the elimination of free radicals, the protection and regeneration of other dietary antioxidants and the chelation of pro-oxidant metals. These properties are due to their redox properties, which allow them to act as reducing agents, hydrogen donors and singlet oxygen quenchers (Lima *et al.*, 2014).

There is also much interest in the healthfulness of citrus fruits because their intakes appear to be associated with reduced risk of certain chronic diseases (Peterson *et al.*, 2006). Besides, bioactive compounds commonly found in fruits, vegetables, herbs and other plants have been shown to have possible health benefits with antioxidative, anticarcinogenic, atherosclerosis, antimutagenic and angiogenesis inhibitory activities. Herbs such as peppermint and lavender were found to have a relatively significant antioxidant activity (63.7 \pm 1.4 per cent and 64.2 \pm 0.7 per cent 2,2-diphenyl-1-picrylhydrazyl radical scavenging activity of 100 $\mu\text{g/mL}$ of each extract, respectively) (Yoo *et al.*, 2008).

Among the used additives with tea is peppermint, which is a famous aromatic used for flavoring gum, toothpaste and tea (University of Maryland Medical Center (UMMC), 2013a). It is also a medicinal herb that is used in traditional and folk medicines in the world for its antimicrobial and antioxidant properties (Tsai *et al.*, 2013). Another herb that is used in tea is lavender, which has a number of beneficial properties for the human body because its flowers, buds and leaves are edible and used for flavoring

(Prusinowska and Śmigielski, 2014). It has also been used as a remedy for a range of ailments from insomnia and anxiety to depression and fatigue (University of Maryland Medical Center (UMMC), 2013b). Infusions and tinctures of lavender flowers have calming, soothing, sedative and analgesic properties (Prusinowska and Śmigielski, 2014).

People have different beliefs about tea and its health effects, as well as using additives with it, such as ginger, lemon, peppermint or even sugar. The most applicable way for gathering information about methods used for brewing tea is a questionnaire. Bouchard *et al.* (2010) used such an approach to analyze the frequency of coffee and tea consumption, and the association of using some additives in coffee or tea with total and abdominal obesity, as well as Demura *et al.* (2013), who examined gender differences in coffee consumption and awareness of its effects in young people. Saalia *et al.* (2013) also used self-administered questionnaires to determine the knowledge and perceptions about beverage creamers among consumers for many West African countries. So by understanding and identifying the most common conditions used among tea consumers around the world, studies considering these conditions can be conducted and have more impact on people's habits and understanding of different tea drinks preparations.

2. Methods

2.1 Sampling

An electronic questionnaire was formed and distributed via Google Drive[®] from 12 November 2014 until the responses were scarce, which was on 10 January 2015; thus, the questionnaire was closed to start the statistical analysis. It contained 18 questions divided into sections, which are illustrated in Figure 1. This method ensured the widest spread of the survey and, as a result, the variety of data collected. In all, 2,690 responses were valid as a sample.

2.2 Statistical analyses

The valid answers received were coded and statistically analyzed using SPSS 20.0 to calculate the frequencies, categorize the data into observed variables by using cross-tabulation and compare the observed data with the author expectations by using the chi-square (χ^2) test technique. The association between drinking tea and gender, age and country, and between using additives and gender, age and country was measured using the χ^2 test, and reported as the Pearson χ^2 value, df (degrees of freedom) and *p*-value. Results were presented as (frequency; percent).

3. Results and discussion

3.1 The respondents

The questionnaire was available online until the responses were scarce; the highest number of responses was observed on the first and second day of questionnaire distribution. The respondents were made of (1,589; 59.1 per cent) men and (1,101; 40.9 per cent) women, with almost equal percentage of non-tea drinkers between them. Most of the respondents were aged between 15 and 24 years (1,361; 50.6 per cent) (Table I), followed by 25 to 34 years (1,048; 39.0 per cent), which could be due to the easy way of spreading the electronic questionnaire among these most available online portions.

The contributors in this study were from all over the world (Table II), with only one thing in common, their ability to read and understand Arabic, as the questionnaire was originally written in Arabic. Thus, most of the participants were from the Arab world

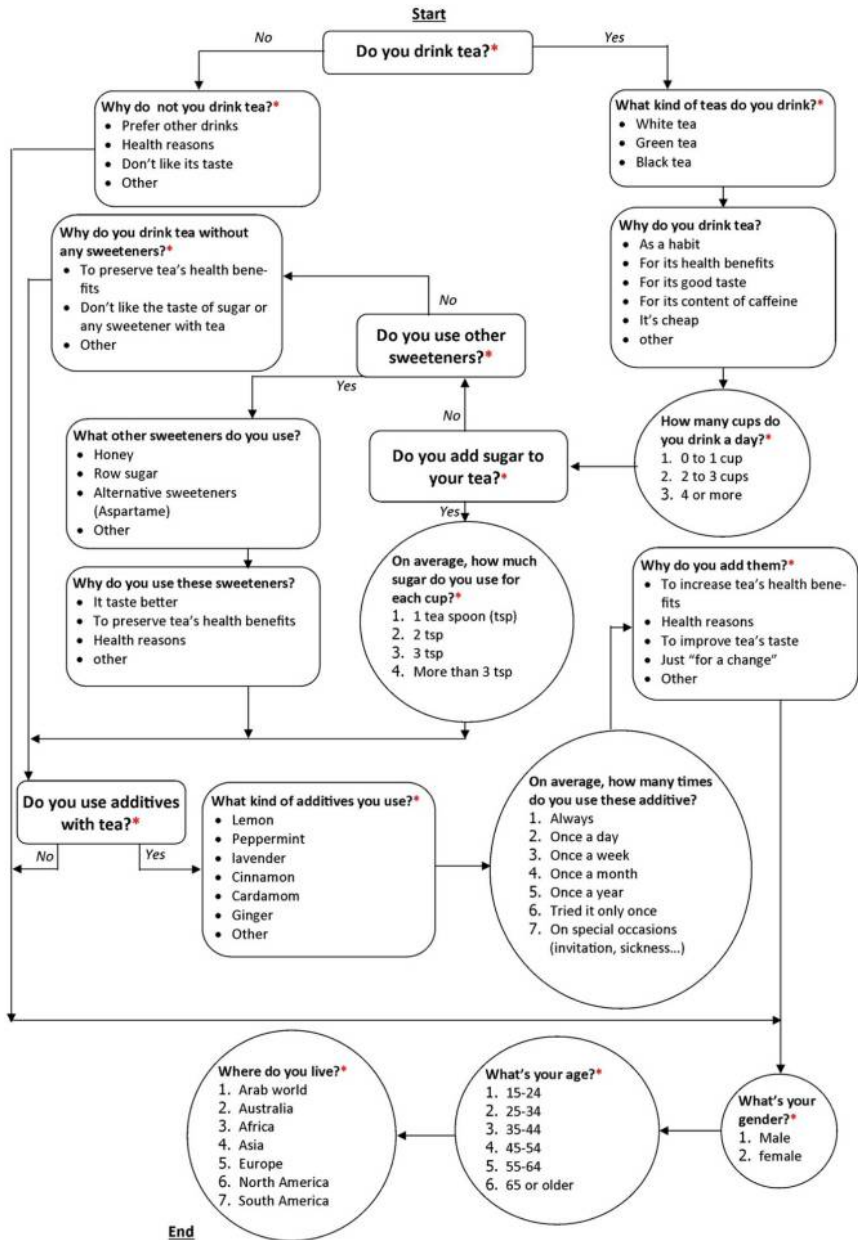


Figure 1. Questions used to form the questionnaire

Notes: Where the oval shape indicates a one-choice question, while the rounded rectangle shape indicates a yes/no question or multiple-choice question. The sequence of the questions given to a respondent depends on his or her answers and * indicates a required question

Gender	Age	Country	Do you drink tea?		How many cups daily: ^a			
			Yes	No	0-1	2-3	4 or more	
Male	15-24	Africa	4	0	3		1	
		North America	12	0	10	2		
		Asia	16	2	9	5	2	
	25-34	Europe	65	3	36	27		
		Arab world	677	33	314	275	88	
		S. America and Australia	2	1	1	1		
	35-44	Africa	4	0	2	2		
		North America	25	0	16	7	2	
		Asia	31	1	9	20	2	
		Europe	83	5	30	39	14	
		Arab world	467	10	153	230	84	
		North America	3	0	2		1	
	45-54	Europe	14	1	5	8	1	
Arab world		72	4	15	38	19		
S. America and Australia		1	0			1		
North America		2	0	1	1	0		
Europe		2	0	1	1	1		
55-64	Arab world	32	0	8	15	9		
	Arab world	12	1	1	9	2		
	North America	1	0	1	1			
	Arab world	2	1	2	2			
65 or older		1,527	62	616	682	229		
Total							(continued)	

Table I.
Demographic characteristics of respondents with their distribution of tea drinkers and how many cups they drink daily

Table I.

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Gender	Age	Country	Do you drink tea?		How many cups daily? ^a			
			Yes	No	0-1	2-3	4 or more	
Female	15-24	S. America and Australia	0	1				
		North America	5	0	4	1		
		Asia	13	2	10	3		
	25-34	Europe	24	2	8	14		2
		Arab world	471	31	228	198		45
		Africa	4	0	2	2		
	35-44	North America	9	0	6	3		
		Asia	9	1	6	2		1
		Europe	48	4	23	20		5
	45-54	Arab world	329	15	145	155		29
		North America	2	0	1	1		
		Asia	3	0	1	2		2
55-64	Europe	4	1	2	2			
	Arab world	67	5	23	34		10	
	S. America and Australia	0	1					
65 or older	North America	3	0	2			1	
	Asia	2	0	1			1	
	Europe	3	0	2			3	
Totals ^b (%)	Arab world	32	1	5	24			
	North America	1	0		1			
	Arab world	6	0	2	2		2	
Total	Arab world	2			2			
	1,037	64	471	465	101			
	2,564	126	1,087	1,147	330			
	95.3	4.7	42.4*	44.7*	12.9*			

Notes: ^a If the respondent answered "Yes" to do you drink tea; ^b frequency is calculated from all respondents; * the percent is based on the tea-drinker respondents' frequency; the association between drinking tea and age, gender and country, $p = 0.127$, $p = 0.027$, $p < 0.001$, respectively

(2,270; 84.4 per cent) and less from Europe (259; 9.6 per cent) and Asia (80; 3.0 per cent), with the majority of them being tea consumers (Table I). There was no significant association between the number of tea drinkers and their age ($\chi^2(5) = 8.57, p = 0.127$); however, the association was observed between the number of tea drinkers and the respondents' gender and country of residence ($\chi^2(1) = 4.90, p = 0.027$; $\chi^2(5) = 34.28, p < 0.001$, respectively). That means that the traditions and culture in different countries affect consuming tea to some extent, more than the age would do. By circling the globe, tea drinks variations of making and enjoying them are as unique as the countries from which they originated (Campbell, 1995), so tea drink becomes more than just a beverage, it is sometimes considered as a ritual ceremony.

The great majority of the participants (2,564; 95.3 per cent) do drink tea, (1,087; 42.4 per cent) of whom drink tea between zero to one cup a day and (1,147; 44.7 per cent) drink two to three cups, while (330; 12.9 per cent) drink four or more cups daily (Table I). The definition of a cup of tea varies in different countries or regions; thus, an image of a mug was associated with this question to indicate the volume of approximately 235 mL (8 ounces) (Higdon, 2008).

There was a variety of reasons for drinking tea (Table III), as "for its health benefits". These benefits include the ability to inhibit the development of cancers of the skin, lung, esophagus, stomach, liver, duodenum and small intestine. And among other benefits, tea has antioxidant capacity, antimicrobial properties, preventing the development of kidney stones, blood glucose-lowering effect, etc. (Sajilata *et al.*, 2008). Drinking tea for its content of caffeine was not as important a reason as others probably because only several participants consider tea as a mild and a good source of caffeine. Still, it is not a primary source of caffeine as coffee (Musallem Al Rasbi and Alam Khan, 2013).

The rest of the participants (126; 4.7 per cent) do not drink tea for several reasons (Table III), such as disliking its taste, which would generally be attributed to its content of polyphenols. Polyphenols are principally responsible for the color and astringency and partially responsible for the flavor of the tea beverage (Harbowy *et al.*, 1997). On the other hand, health reasons as well as preferring other drinks were much less causes for not drinking tea among the respondents.

3.2 Tea infusion variations

When the participants were asked about their preferred tea type, most chose black tea (2,446; 95.4 per cent), as expected because it is the most popular in the Arab world. Few

Country	Frequency ^a	(%) ^a
South America	2	0.1
Australia	4	0.1
Africa	12	0.4
North America	63	2.3
Asia	80	3.0
Europe	259	9.6
Arab world	2,270	84.4

Note: ^aFrequency and percent are calculated from all respondents; results are presented as (frequency; percent)

Table II.
The distribution of respondents among country of residence around the world

NFS 46,4	Variable ^b	Frequency ^a	(%)*
	<i>Reasons for drinking tea</i>		
	For its good taste	1,638	5.9
	As a habit	1,500	24.9
	For its health benefits	638	63.9
590	For its content of caffeine	397	15.5
	It's cheap	151	58.5
	Other	166	6.5
	No answer	11	0.4
	<i>Reasons for not drinking tea^c</i>		
	Don't like its taste	27	21.4
	Health reasons	13	10.3
	Prefer other drinks	13	10.3
	Other	10	7.9

Table III. Frequency and percentage of the main reasons for drinking or not drinking tea

Notes: ^aFrequency is calculated from all respondents; ^bmultiple-choice questions; ^crequired question; *the per cent is based on the respondents' answer to whether they drink tea or not

participants drink green tea (117; 4.6 per cent). Only very few of the participants drink white tea (2; 0.1 per cent), probably because it is not as popular as black or green tea, all originating from the same plant, *Camellia sinensis*, family Theaceae. White tea is different in its processing steps, for the leaves only go through the drying process, which maintains its content of polyphenols (Alhafez *et al.*, 2014), making its taste even more bitter.

A lot of tea-drinking respondents add sugar to their drink (2,242; 87.4 per cent), on average two teaspoons per cup (Table IV). On the other hand, some of the respondents who do not use sugar use other sweeteners (84; 26.1 per cent), such as artificial sweeteners (Aspartame) or honey, mainly for health reasons. Other respondents do not use any sweeteners at all (238; 73.9 per cent), which was greatly attributed to their dislike of the taste of sugar or sweeteners with tea. Some respondents thought that adding sugar would reduce tea's health benefits; therefore, they use other sweeteners or none, but Peters *et al.* (2010) found that adding sucrose (table sugar) may improve catechin bioavailability by enhancing bioaccessibility and intestinal uptake from tea.

3.3 Using additives with tea infusions

The great majority of the respondents would drink their tea with additives (natural flavoring) (1,814; 70.7 per cent), mostly once a week or during periods of sickness (Table V). There was a significant association between the number of people using additives and their gender and country of residence ($\chi^2(2) = 12.03, p = 0.002$; $\chi^2(10) = 39.43, p < 0.001$, respectively), which also indicates the possible effect of traditions and culture on the tea drink. It was also noticed that the respondents from southern hemisphere countries (South America, Africa and Australia) do not use much of the mentioned natural flavoring, and that might be due to the availability of different herbs. On the other hand, the association with age was not significant ($\chi^2(10) = 11.34, p = 0.332$), but the participants older than 55 would use very few additives such as lemon or peppermint, may be because they are more accustomed to them. The most used additive

Variable	Frequency ^a	(%)*
<i>Average amount of sugar teaspoons (tsp.)^c</i>		
1 tsp.	608	27.1
2 tsp.	1,014	45.2
3 tsp.	503	22.4
More than 3 tsp.	116	5.2
<i>Sweeteners instead of sugar^b</i>		
Alternative sweetener (Aspartame)	40	47.6
Honey	23	27.4
Brown sugar	11	13.1
Other	11	13.1
No answer	3	3.6
<i>Reasons for using other sweeteners^b</i>		
Health reasons	58	69.0
Taste better than sugar	20	23.8
To maintain tea's benefits	10	11.9
Other	7	8.3
No answer	3	3.6
<i>Reasons for not using any sweeteners^{b,c}</i>		
Dislike the taste of sugar or any other sweeteners	134	56.3
To maintain tea's benefits	64	26.9
Other	55	23.1

Table IV.
Frequency and percentage of sweeteners used by respondents instead of sugar, the factors affecting their choices and the main reasons for not using any sweeteners

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among the respondents was peppermint, followed by lemon and cinnamon, while only few would use lavender (Table V). Causes for drinking tea with these additives were imputed to improving tea's taste, just for a change of habit or increasing its health benefits within other reasons also mentioned in Table V. It was suggested in previous studies that adding lemon or other citrus juices to tea drink would make it easier to digest most of its polyphenols (Peters *et al.*, 2010; Green *et al.*, 2007). On the other hand, many websites advertise the health benefits of drinking green tea and mint (Wright, 2010; McCarthy, 2014; Haris, 2014), but their references do not clearly explain the effect of adding mint to green tea drink. Despite the fact of both have improving health benefits, mixing them does not ensure the mixture to have the same effect; this raises many questions that are yet to be answered.

4. Conclusion

Tea is a worldwide popular drink among both men and women, and it is used by all ages. Many of the participants in this study prefer their tea with sugar, while a good part of the participants would prefer drinking tea without any sweetener. These participants thought that adding any sweetener would reduce tea's health benefits, but that notion would require much further examination. A great majority of the respondents would use natural flavoring with their tea, such as peppermint, lemon, cinnamon and lavender. Improving tea's taste was the most picked option, while some participants thought that

NFS 46,4	Variable	Frequency ^a	(%)*
	<i>Additives (natural flavoring)^{b,c}</i>		
	Peppermint	1,052	58.0
	Lemon	607	33.5
	Lavender	26	1.4
592	Cinnamon	580	32.0
	Cardamom	128	7.1
	Ginger	101	5.6
	Other	30	1.7
	<i>Frequency of drinking tea with additives</i>		
	Always	311	17.1
	Once a day	249	13.7
	Once a week	453	25.0
	Once a month	324	17.9
	Once a year	69	3.8
	Tried it only once	14	0.8
	On special occasions	389	21.4
	No answer	5	0.3
	<i>Reasons^{b,c}</i>		
	Improve tea's taste	1,040	57.3
	Just "for a change"	736	40.6
	Increase tea's health benefits	548	30.2
	Health reasons	222	12.2
	Other	48	2.6
Table V. Frequency and percentage of the additives used by respondents, their frequency of usage and main reasons for using them with tea drink	Notes: ^a Frequency is calculated from all respondents; ^b multiple-choice questions; ^c required question; the association between adding additives and age, gender and country; $p = 0.332$, $p = 0.002$; $p < 0.001$, respectively; *the percent is based on the respondents' answer to whether they use additives or not.		

adding such natural flavoring might improve tea's health benefits, which also needs thorough investigation.

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