

*Original Article*

Determining The Caffeine Content of Certain Types of Coffee in Western Libya and Gastrointestinal Symptoms

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Abstract

Background: Coffee is one of the most popular and widely consumed beverages in the world, as its caffeine content stimulates individuals. It remains one of the most popular drinks globally to this day. Coffee is made from roasted coffee beans, which are grown in more than 70 countries, particularly in the tropical regions of Africa, Southeast Asia, the Indian subcontinent, and North and South America. The aim is to evaluate the relationship between coffee consumption and gastrointestinal symptoms, particularly abdominal pain. It also sought to determine the caffeine content of six types of coffee available in markets in western Libya. **Method:** Data were collected through a questionnaire completed by 192 participants. The questionnaire included information on demographic characteristics, coffee consumption patterns, and associated gastrointestinal symptoms. Data analysis was done in SPSS Inc., Chicago, IL, USA, version 26.0, with the statistical significance level set at $p < 0.05$. In addition, caffeine was extracted from coffee and instant coffee using a spectrophotometric method. The process was repeated three times to obtain the final result for the caffeine content in coffee and instant coffee brands widely available in the Libyan market. **Results:** showed that a percentage of participants experienced gastrointestinal symptoms after consuming coffee; however, no statistically significant association was observed between the type of coffee or its consumption pattern and abdominal pain. The improvement in symptoms after reducing coffee consumption varied among the participants. Additionally, the caffeine content of the six types of coffee commonly available in the western Libyan market was analysed. Essam coffee was found to contain 1.82% caffeine, Yemen coffee 1.19%, and Khalid coffee 1.28%. As for Nescafé, we used its caffeine content, which was 3.31% for Recharge, 1.13% for Napoli, and 2.66% for Stella. **Conclusion:** The effect of coffee on gastrointestinal symptoms appears to be individual rather than general, as no statistically significant relationship was observed within the study sample.

Keywords: coffee, Libya, stomach problem, caffeine

Introduction:

Coffee's stimulating effects on the central nervous system, along with its flavour and aroma, make it one of the most popular and commonly consumed beverages in the world. Caffeine and chlorogenic acids are the most prevalent compounds in coffee, a complex mixture of around 800 volatile molecules [1]. Coffee beans are grown in more than 70 countries, mostly in tropical regions of Africa, Southeast Asia, North and South America, and the Indian subcontinent. Coffee is a beverage produced from roasted coffee beans. [2] It is estimated that, after crude oil, green coffee beans are the second most traded commodity globally. Coffee has a stimulating effect on people because of its caffeine content. One of the most consumed drinks in the world today is coffee [3]. Making a substantial contribution to the economies of numerous nations that produce coffee. Every day, more than 2.2 billion cups of coffee are drunk worldwide, with more than 400 million of those cups being eaten in the US alone [4]. Coffee arabica L. (Arabica coffee) and C. canephora A. Froehner (robusta coffee) are the two primary species of coffee that are grown. Arabica coffee output reached 6.1 million tons worldwide in 2020–2021, while robusta coffee production reached 4.5 million tons. It is anticipated that demand will rise in the upcoming years [4]. Probably the most often

consumed pharmacologically active drug in the world is caffeine. Common drinks (coffee, tea, and soft drinks), goods that contain chocolate or cocoa, and pharmaceuticals all contain it [5]. Both the general public and the scientific community are interested in the possibility that caffeine could have negative health effects because it is widely used in varying quantities by the majority of the population. A thorough literature search yielded reviews of (mostly) published human research, which were used to examine the hypothesis that caffeine use has a negative impact on human health [5]. The public's health could be significantly impacted by excessive coffee drinking. Thus, it is not surprising that coffee piques the curiosity of scientists and medical professionals. In May 2017, the search "coffee" yielded 12,583 results in PubMed, including 1,666 clinical trials and 998 reviews. Although coffee has gradually shifted to a less negative position due to its better-known pharmacology, the impact of coffee consumption on chronic diseases has been a topic of debate for the past 20 years, with some conflicting results due to the retrospective nature of most studies. [1] According to new methods in epidemiological data and experimental studies, coffee drinking may lower the risk of some chronic and degenerative illnesses. The most important preventive



effects of coffee on diabetes, liver disease, cardiovascular disease, and gastrointestinal disorders—particularly IBD—are reviewed in this publication. If at all possible, the role of caffeine and polyphenols is described together with a discussion of clinical and experimental investigations. [1]

Effects of Coffee on the Cardiovascular System :

The link between coffee drinking and the risk of CVD is a topic of considerable debate. Due to the high incidence of both coffee drinking and coronary heart disease in Western nations, the association between coffee intake and the risk of coronary heart disease was initially investigated in the 1960s [6]. Although the form of the association is still unknown, these meta-analyses did not show a link between coffee intake and an increased risk of CVD. Interestingly, a 2014 meta-analysis [7] found that heavy coffee intake (≥ 6 cups/day) was neither linked to a reduced nor a higher risk of CVD, but moderate coffee consumption (3–5 cups/day) was linked to a decreased risk of CVD.

Coffee and Type 2 Diabetes :

In vivo studies have demonstrated coffee's health benefits against metabolic illnesses, particularly type 2 diabetes, and it has recently gained scholarly interest as a contemporary epidemiology [8]. The majority of investigations, albeit not all of them, have confirmed an inverse link. Consequently, [7] presented an updated systematic review and a dose-response meta-analysis of all available data on the association between the incidence of type 2 diabetes and the use of both caffeinated and decaffeinated coffee [7]. Coffee consumption and the risk of diabetes are strongly inversely correlated, according to a systematic review and meta-analysis based on 1,109,272 study participants and 45,335 type 2 diabetes cases. Six cups of coffee per day were linked to a 33% decreased incidence of type 2 diabetes when compared to not drinking any coffee at all. Both men and women showed the same association [7].

Coffee and Liver Diseases:

Coffee consumption has been shown to have preventive benefits against the onset and progression of liver disease from a variety of causes. Wadhawan and Anand evaluated the clinical evidence of coffee consumption's benefits for hepatitis B and C, nonalcoholic fatty liver disease, and alcoholic liver disease in 2016 [9], while Liu et al. reviewed it in 2015 [10] for hepatic fibrosis and cirrhosis. Two recent population-based studies, the NHANES I and III [11,12], support this protection by showing that those who drink more coffee (> 2 cups daily) have a 44% lower risk of elevated ALT levels and a lower risk of chronic liver disease when compared to those who do not drink coffee.

Prevention of Parkinson's disease : Caffeine and coffee use are generally inversely correlated with the risk of Parkinson's disease, according to case-control study data. [13] In addition, a number of sizable prospective cohort studies have discovered negative correlations between

coffee and caffeine use and the risk of Parkinson's disease in men. According to research on over 8,000 Japanese-American men, those who drank at least 28 ounces of coffee a day had a 3–5 times higher chance of developing Parkinson's disease during the following 24–30 years than those who did not [14].

Cancer

Antioxidants included in coffee have been demonstrated to stop free radicals from damaging cells, which can result in cancer. How and how long the beans are roasted determines the degree of oxidation. Research indicates that roasted coffee has more antioxidants than green coffee [15]. Coffee and caffeine consumption and human cancer risk have been the subject of numerous epidemiological studies. Generally speaking, there isn't much proof that drinking coffee raises your chance of developing cancer, especially when cigarette smoking is taken into account. [5]

Depression : Coffee drinking was found to be negatively linked with the probability of developing clinical depression in a ten-year study of 50,739 women in the United States (average age 63) who were initially free of depressive symptoms (in 1996) [16]. Found a negative correlation between coffee drinking and suicide rates. It has been proposed that caffeine lessens depressive symptoms by preventing adenosine's inhibitory effects on dopamine neurons in the brain. Additionally, coffee consumption is linked to better endothelial function. [17]

Coffee and Inflammatory Bowel Disease :

According to current research, coffee use is not linked to an increased incidence of stomach cancer [18], gastritis, and peptic ulcers [19]. Dyspepsia [20], or gastroesophageal reflux disease [22,21]. Although many with IBD also drink coffee, it is still unclear if coffee is safe for those who have a chronic digestive illness.

Materials and Methods:

Study Design and Period: For data collection and the distribution of our questionnaire, we handed out the questionnaire online using social networks such as Facebook, WhatsApp, Telegram, Viber, and Instagram. The inclusion criteria of our study consisted of all Libyan people who live in Libya only. Additionally, IP filtering was employed to prevent duplicate replies, and participants had the option to withdraw at any moment throughout the survey.

Study Population:

The sample size was 192 participants who regularly consume coffee. This study employed a descriptive-analytical approach, targeting a sample of individuals who regularly consume coffee. Data were collected using a questionnaire specifically designed for this study, which included demographic information such as age, gender, marital status, educational level, and smoking status, in addition to questions about coffee consumption patterns, including coffee type, frequency, timing, and preparation method. The questionnaire also included items assessing



the occurrence of various gastrointestinal symptoms following coffee consumption, the extent of symptom improvement after reducing intake, and participants' beliefs regarding the role of caffeine in causing these symptoms. In addition, caffeine was extracted from coffee and instant coffee using a spectrophotometric method. This method relies on the spectroscopic determination of caffeine based on its absorption of ultraviolet light at a wavelength of 272-274 nm. Using a UV-Vis spectrophotometer, standard caffeine, methanol, or distilled water, the process was repeated three times to obtain the final result for the caffeine content in coffee and instant coffee brands widely available in the Libyan market.

Data Analysis:

Data analysis was done in SPSS Inc., Chicago, IL, USA, version 26.0, with a significance level set at $p < 0.05$. The study employed descriptive analysis to display the frequency and proportion of each response for categorical (demographic) factors. The results were summarised in one-dimensional tables for all data, which include the comparison between drinking coffee and having stomach problems. In addition, the questionnaire also included items assessing the occurrence of various gastrointestinal symptoms following coffee consumption, the extent of symptom improvement after reducing intake, and participants' beliefs regarding the role of caffeine in causing these symptoms.

Results:

The descriptive analysis showed that the majority of participants consume coffee regularly, with variations in preferred coffee type, frequency of consumption, and timing of intake. The results also indicated that a considerable proportion of participants reported experiencing gastrointestinal symptoms after drinking coffee. The most commonly reported symptoms were abdominal pain, bloating, and heartburn, while symptoms such as constipation or diarrhea were relatively less frequent. The findings further revealed that most participants did not report an immediate increase in symptoms following coffee consumption, whereas some indicated that symptoms appeared after a period of time, reflecting individual differences in physiological response. A portion of the sample reported improvement in symptoms after reducing coffee consumption, while others did not observe any notable change. When examining the relationship between coffee type and the occurrence of gastrointestinal symptoms, the statistical analysis did not demonstrate a significant association, as the p -values exceeded the established level of significance. This suggests the absence of a direct statistical relationship between these variables within the study sample.

Table 1 shows the statistical relationship between the time of coffee consumption and the occurrence of heartburn

Time of coffee consumption	sometimes	no	yes	Missing	All
After breakfast	7	42	8	0	57
	12.28	73.68	14.04	*	100.00
Afternoon	22	50	9	0	81
	27.16	61.73	11.11	*	100.00
On an empty stomach	13	33	7	0	53
	24.53	62.26	13.21	*	100.00
Missing	0	0	0	1	*
	*	*	*	*	*
All	42	125	24	*	191
	21.99	65.45	12.57	*	100.00

Although heartburn was reported more frequently among participants who drank coffee at different times, the statistical analysis did not reveal a statistically significant association between the timing of coffee

consumption and the onset of heartburn. This suggests that the occurrence of symptoms may be related to other factors such as the type of coffee, the frequency of consumption, or individual gastrointestinal sensitivity.

Table 2 shows the relationship between the frequency of daily coffee consumption and the occurrence of diarrhoea

Daily coffee consumption	sometimes	no	yes	Missing	All
More than once	3	29	1	0	33
	9.09	87.88	3.03	*	100.00



once	8	98	4	0	110
	7.27	89.09	3.64	*	100.00
twice	3	40	5	0	48
	6.25	83.33	10.42	*	100.00
Missing	0	0	0	1	*
	*	*	*	*	*
All	14	167	10	*	191
	7.33	87.43	5.24	*	100.00

The study included 192 participants. The results showed that 87.43% of participants did not experience diarrhea after drinking coffee, while 7.33% reported experiencing it occasionally, and 5.24% reported experiencing diarrhea after drinking coffee. When analysing the relationship between the frequency of daily coffee consumption and the occurrence of diarrhea, the incidence was higher among those who drank coffee twice daily (10.42%) compared to those who drank coffee once daily (3.64%) or more than once daily (3.03%). However, the chi-square test showed no statistically significant relationship between the frequency of coffee consumption and the occurrence of

diarrhoea, with a p-value of 0.456, which is higher than the significance level of 0.05. Therefore, the results of this study indicate that the frequency of coffee consumption is not statistically significant in relation to the occurrence of diarrhoea in the study sample. Although caffeine is known for its stimulating effect on bowel movements, the results of this study did not show a statistically significant relationship, which may be due to physiological adaptation in people accustomed to drinking coffee, differences in digestive system sensitivity between individuals, or the influence of other factors such as the type of coffee or the method of preparation.

Table 3. shows the relationship between the time of drinking coffee and cramps and spasms after drinking it

Type of coffee	sometimes	no	yes	Missing	All
Arabic	9	62	6	1	77
	11.69	80.52	7.79	*	100.00
Nescafe	10	28	6	0	44
	22.73	63.64	13.64	*	100.00
Both of them	19	45	4	0	68
	27.94	66.18	5.88	*	100.00
Missing	0	1	0	1	*
	*	*	*	*	*
All	38	135	16	*	189
	20.11	71.43	8.47	*	100.00

The results showed that colic and cramps after drinking coffee were more common among instant coffee consumers and those who drank both types compared to Arabica coffee consumers. However, the relationship did not reach statistical significance ($P = 0.077$), with a trend suggesting a possible association between the type of coffee and digestive symptoms. The higher incidence of colic and cramps among instant coffee consumers and

those who drank both types can be explained by the following: Instant coffee (Nescafé) contains a higher acidity level, additives, and stomach irritants. Caffeine leads to increased intestinal motility and stimulation of gastric acid secretion. Arabica coffee is generally less acidic, prepared with a milder concentration, and contains additives such as cardamom, which may reduce digestive irritation.

Table 4 shows the caffeine content in Coffee and Nescafé commonly consumed in Western Libya

Caffeine content	Sample name	Number
%1.82	Essam's Coffee	1
%1.19	Yemeni coffee	2



%1.28	Khalid Coffee	3
%3.31	Recharge Nescafe	4
%1.13	Napoli Nescafe	5
%2.66	Stella Nescafe	6

In the table, the caffeine content in the 6 most popular types of coffee and Nescafé consumed in western Libya by the Libyan Advanced Centre for Chemical Analysis. The highest caffeine content was in Nescafé Recharge, at 3.31%, and the lowest caffeine content was in Nescafé

Discussion

The connection between coffee drinking and a number of medical disorders has been the subject of much scientific investigation. Most members of the broader medical community concur that healthy people should consume coffee in moderation since it is either required or at the very least, advantageous. In a 2012 study on food and health, the American Society for the Care of Retired Persons and the World Health Organisation examined the connection between death rates and coffee drinking. The researchers discovered that coffee drinkers lived longer than non-drinkers and that the amount of coffee drunk was inversely linked to the mortality rate [22]. However, the study concluded, "Whether this is causal cannot be determined by research." In 2012, the New England Journal of Medicine conducted a similar study with identical results [22]. The 22-year-old Harvard School of Public Health study participants "indicate that coffee may have potential health benefits, but more research needs to be done," the researchers said [23]. The findings also contradicted one another about the possible negative effects of coffee use as well as if coffee has any particular health benefits. Additionally, differences in age, sex, health, and consumption level confounded the findings and generalizations. Coffee's effects on the stomach may raise the risk of esophageal burns, gastritis or ulcers, gastro-esophageal reflux disease, and dyspepsia (difficulty, nausea, heartburn, eructation, and flatulence) [24]. The painful reflux disease known as GERD is brought on by stomach acid refluxing back into the esophagus. Although not all studies have observed it, coffee has been thought to lower baseline lower esophageal sphincter (LES) pressure, which could result in heartburn and gastroesophageal reflux [25]. A decreased risk of GERD in coffee consumers was reported in two European studies whose outcomes varied with the group considered. While the first trial indicated that coffee did not significantly reduce the frequency or severity of GERD symptoms, the same study found that frequent coffee drinking only increased the frequency and severity of GERD symptoms in individuals with severe or chronic GERD [26]. Coffee drinking was linked to a dose-dependently

Napoli, at 1.13%. Yemen coffee had a caffeine content of 1.19%, Khalid coffee had a caffeine content of 1.28%, Essam coffee had a caffeine content of 1.82%, and Nescafé Stella had a caffeine content of 2.66%.

lower risk of GERD in the second research, but only in male participants; women showed no change in risk [27]. Coffee does not seem to have a substantial impact on the risk of peptic ulcers, and a more recent investigation in the Danish population found similar risk variables [28]. Coffee promotes colonic motility in 29% of participants [29], while it has no effect on small intestine motility [30]. Compared to water, regular and decaffeinated coffee causes a significant increase in colon activity, which results in a greater number of pressure waves and propagating contractions. But our study aimed to evaluate the relationship between coffee consumption patterns and the occurrence of gastric symptoms, particularly heartburn after coffee intake, among a sample of participants with diverse demographic characteristics. The descriptive findings indicated that coffee consumption is a common behaviour among the study participants, with variations in the timing of intake, including after breakfast, in the afternoon, and on an empty stomach. A number of participants also reported experiencing heartburn symptoms after drinking coffee, with varying degrees of severity. The results of the statistical analysis using the Chi-square test demonstrated no statistically significant association between the timing of coffee consumption and the occurrence of heartburn, as the p-value exceeded the accepted significance level (0.05). This finding suggests that the timing of coffee intake alone is not a decisive factor in the development of heartburn symptoms among the studied sample. Despite the absence of statistical significance, the observed relative differences among the different groups may reflect individual variations in gastrointestinal responses to caffeine and other coffee components. It is likely that multiple factors contribute to the development of gastric symptoms, including the type of coffee consumed, daily coffee intake, preparation method, as well as individual dietary habits and overall lifestyle. These findings are consistent with some previous studies that reported variability in the effects of coffee on the gastrointestinal system among individuals and emphasized that symptom occurrence is not dependent on a single factor. Conversely, other studies have reported associations between coffee



consumption and certain gastric disorders; however, those studies often accounted for additional factors such as caffeine concentration, the addition of milk or sugar, and the presence of pre-existing gastrointestinal conditions, which may explain the discrepancies in findings. Although this study did not establish a statistically significant relationship between coffee intake timing and heartburn, the results hold practical significance by emphasizing the importance of individual awareness and self-monitoring of personal responses to coffee consumption, particularly among individuals experiencing recurrent gastrointestinal symptoms. Furthermore, the findings suggest that complete abstinence from coffee may not be necessary for all individuals, and that modifying consumption patterns may represent a more appropriate approach. It should be noted that this study has several limitations, including reliance on self-reported data and the lack of in-depth assessment of certain confounding variables that may influence gastric health. Additionally, the study was conducted on a specific sample, which may limit the generalizability of the findings to broader populations. Based on these findings, future research is recommended to further investigate the effects of coffee type, caffeine content, and frequency of consumption, as well as the interaction between coffee intake and other factors such as smoking and dietary patterns, in order to achieve a more comprehensive understanding of the impact of coffee on gastrointestinal health.

Conclusion

This study sought to evaluate the relationship between coffee consumption patterns and gastrointestinal

symptoms, with particular emphasis on abdominal pain, among individuals in Libya. Despite a proportion of participants reporting gastrointestinal discomfort following coffee intake, statistical analysis did not demonstrate a significant association between the type, frequency, or pattern of coffee consumption and abdominal pain within the study sample. The findings suggest that the gastrointestinal effects of coffee are likely influenced by individual variability rather than representing a consistent or generalized physiological response. Differences in caffeine metabolism, gastric sensitivity, lifestyle behaviors, and underlying gastrointestinal conditions may contribute to the heterogeneous responses observed among participants. Consequently, the relationship between coffee consumption and gastrointestinal symptoms appears to be multifactorial and complex. Although no statistically significant association was established, the subjective improvement reported by some participants after reducing coffee intake highlights the potential relevance of individualized dietary assessment. Therefore, clinical and public health recommendations regarding coffee consumption should consider personal tolerance and symptom patterns rather than applying universal restrictions. Future research employing larger sample sizes, longitudinal or experimental study designs, and objective clinical assessments is warranted to further elucidate the mechanisms underlying the interaction between coffee intake and gastrointestinal health.

Conflict of interest: The authors declare that there is no conflict of interest regarding the publication of this paper.

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