TABORSKA, Nina, MARTYKA, Anna, KUBICKA FIGIEL, Martyna and UJMA, Przemysław. The impact of consumed coffee on the digestive system - review of the latest research. Journal of Education, Health and Sport. 2024;53:32-43. eISSN 2391-8306.
https://dx.doi.org/10.12775/JEHS.2024.53.003
https://apcz.umk.pl/JEHS/article/view/47791
https://zenodo.org/records/10510825

The journal has had 40 points in Ministry of Education and Science of Poland parametric evaluation. Annex to the announcement of the Minister of Education and Science of 05.01.2024 No. 32318. Has a Journal's Unique Identifier: 201159. Scientific disciplines assigned: Physical culture sciences (Field of medical and health sciences); Health Sciences (Field of medical and health sciences).
Punkty Ministerialne z 2019 - aktualny rok 40 punktów. Załącznik do komunikatu Ministra Edukacji i Nauki z dnia 05.01.2024 Lp. 32318. Posiada Unikatowy Identyfikator Czasopisma: 201159. Przypisane dyscypliny naukowe: Nauki o kulturze fizycznej (Dziedzina nauk medycznych i nauk o zdrowiu); Nauki o zdrowiu (Dziedzina nauk medycznych i nauk o zdrowiu).

The authors declare that there is no conflict of interests regarding the publication of this paper.
Received: 04.01.2024. Revised: 06.01.2024. Accepted: 09.01.2024. Published: 14.01.2024.

The impact of consumed coffee on the digestive system- review of the latest research

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Abstract

Introduction

Coffee stands as the second most widely consumed beverage globally, following water.[1] Recent research on the effects of coffee consumption underscores its positive outcomes when adhering to recommended doses—typically ranging from 2 to 5 cups a day, amounting to a maximum of 400 mg of caffeine daily. This newfound perspective highlights the potential benefits of moderate coffee intake on our overall health and well-being.

Aim of the study

The objective of this study was to comprehensively review the existing knowledge regarding the impact of coffee consumption on diverse aspects of the gastrointestinal tract.

Materials and methodology

We systematically searched the PubMed database for relevant literature. Articles were specifically sought in English, employing the following keywords: coffee, caffeine, digestive system, digestion, Helicobacter pylori, and cancer.

Results

Recent research highlights coffee's diverse benefits, aiding digestion, hastening transit, and showing potential in cancer prevention. It stimulates gastric acid, enhances bile and pancreatic secretion, reduces gallstone risk, promotes large intestine movement, and modulates intestinal flora. Importantly, coffee isn't a primary factor in conditions like reflux, ulcers, inflammatory bowel diseases, or cancer.

Conclusions

Further research is essential to deepen our understanding of coffee's impact on the digestive system and its systemic effects on the body. Additionally, promoting awareness of safe daily caffeine doses that can contribute to health is worthwhile.

Keywords: coffee, caffeine, digestive system, digestion, Helicobacter pylori, cancer

I.Introduction

Ia. Caffeine: Impact, Safety, and Daily Consumption

Coffee enjoys widespread popularity globally, with an estimated daily consumption surpassing two billion cups worldwide. In the United States, the average daily caffeine intake stands at 135 milligrams, approximately equivalent to 1.5 cups of coffee. Nevertheless, a substantial number of individuals indulge in as much as 6 cups per day, resulting in considerably elevated caffeine consumption [2].

Caffeine, classified as a purine alkaloid, is an organic chemical compound present in coffee beans and various plant sources like tea and cocoa. As a psychoactive drug, it falls under the category of stimulants.

Upon oral consumption, caffeine is rapidly and nearly entirely absorbed by the stomach, achieving peak concentrations in the bloodstream within 20-40 minutes. With a half-life ranging from 3 to 10 hours, caffeine exhibits a prolonged presence in the body post-consumption.

The lethal oral dose of caffeine is estimated to be around 10 grams, corresponding to a blood concentration of 80-100 μg/ml. The risk of caffeine poisoning is minimal through regular food consumption, primarily arising from excessive intake of supplements or medications containing caffeine [3].

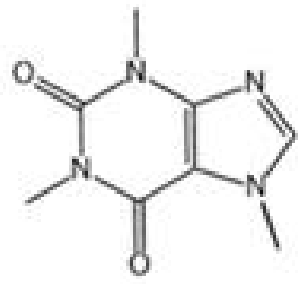

Figure 1. The chemical structure of the coffee ingredient – caffeine [4]

II.Aim of the study

The objective of this study was to comprehensively review the existing knowledge regarding the impact of coffee consumption on diverse aspects of the gastrointestinal tract.

III. Materials and methodology

We systematically searched the PubMed database for relevant literature. Articles were specifically sought in English, employing the following keywords: coffee, caffeine, digestive system, digestion, Helicobacter pylori, and cancer.

IV. Results

IVa.Coffee Consumption and Gastroesophageal Reflux Disease

Gastroesophageal reflux disease (GERD) is a persistent condition characterized by the abnormal backflow of stomach contents into the esophagus. Common symptoms include heartburn, a burning sensation behind the sternum, resulting from the irritating impact of

regurgitated stomach contents mixed with hydrochloric acid and digestive enzymes [5]. Despite the chronic nature of GERD, numerous studies generally do not establish a clear association between coffee consumption and the onset or exacerbation of symptoms related to reflux esophageal disease [6, 8].

A study conducted among a Taiwanese population found no significant correlation between coffee consumption and symptoms of Gastroesophageal Reflux Disease (GERD) [7]. However, divergent findings from other studies suggest a potential adverse impact of coffee on the lower esophageal sphincter (LES). These studies propose that coffee may lead to a reduction in LES pressure, potentially facilitating the regurgitation of stomach contents. It is essential to recognize that the timing of coffee consumption, such as having it with meals or immediately afterward, can influence test outcomes. Given the ambiguous nature of data regarding the relationship between coffee intake and reflux symptoms, researchers do not advocate for the complete avoidance of coffee in GERD [6].

IVb. Exploring the Relationship Between Coffee and Stomach Health

Coffee, a globally consumed beverage, has garnered attention regarding its influence on stomach health. Researchers have particularly explored its potential association with stomach ulcers, a condition marked by defects in the mucous membrane that result in discomfort and pain during meals [11]. While historical perspectives implicated coffee in the risk of stomach ulcers, modern research is providing fresh insights into the role of Helicobacter pylori (H. pylori) bacteria in ulcer development [12, 29].

- **Coffee and Stomach Ulcers**

Contrary to past beliefs, recent analyses of risk factors for gastric ulcers highlight that coffee is no longer considered a significant contributor to this condition. A Dutch cohort study involving 2,416 participants identified H. pylori infection, smoking, and sedative use as the primary risk factors for gastric ulcers, with no conclusive evidence implicating coffee consumption. These findings were corroborated by a 2012 cross-sectional study conducted in Japan, encompassing 8,013 healthy subjects, which found no significant association between coffee intake and the risk of gastric ulcers [12].

Current evidence suggests that coffee consumption may not be a major risk factor for stomach ulcers, and the focus has shifted towards understanding the role of H. pylori infection and

other factors in ulcer development. Further research is needed to elucidate the complex interplay between lifestyle, bacterial infections, and stomach health.

- **Investigating the Relationship Between Coffee and Gastritis**

Gastritis, encompassing situations where the innermost layer of the stomach wall (mucosa) is damaged, is a multifaceted condition with various causes, including infections, autoimmune processes, drug use, and hypersensitivity to external factors [10, 28, 29]. This study delves into the potential association between coffee consumption and gastritis, considering factors such as smoking and alcohol consumption.

In a comprehensive prospective cohort study involving 47,806 men, researchers observed 138 new cases of gastritis over a six-year follow-up period. The findings of this study revealed no significant association between gastritis and coffee consumption, smoking, or alcohol intake. The results suggest that coffee consumption may not be a contributing factor to the development of gastritis in the studied population [9].

Contrary to some expectations, the data from this study do not support a link between coffee consumption and the occurrence of gastritis. However, it is crucial to recognize that gastritis is a complex condition influenced by various factors, and further research is essential to comprehensively understand the interplay between lifestyle choices, dietary habits, and the development of gastritis.

IVc. Impact of Coffee Consumption on Gallbladder and Pancreatic Function

The gallbladder, situated beneath the liver, plays a crucial role in processing bile produced by the liver. Bile, with its emulsifying properties, aids in breaking down fat particles, supporting their digestion and absorption in the digestive tract [13, 14].

Studies indicate that both forms of coffee, whether caffeinated or decaffeinated, can trigger the release of cholecystokinin (CCK), a hormone responsible for activating the secretion of enzymes and bile from the gallbladder and pancreas into the intestine. This effect has been observed irrespective of caffeine content, suggesting an elevation in CCK levels in the blood and an increase in gallbladder contractions. Notably, this phenomenon holds true for both types of coffee. Moreover, CCK's role in stimulating pancreatic secretion, containing essential enzymes for fats, proteins, and carbohydrates' digestion, underscores the broader impact of

coffee on digestive processes. Recent research further hints at a potential association between coffee consumption and a decreased risk of pancreatitis. Analyses focused on gallbladder function also propose that regular coffee intake might contribute to a lower risk of gallbladder diseases [15].

IVd. Coffee and liver diseases

The liver, a vital organ in many organisms, including humans, stands as one of the largest and most significant glands. Its multifaceted functions are pivotal for maintaining the body's homeostasis and overall health. Here aresomeessentialliverfunctions [16, 30, 31]:

- **Metabolism:** The liver actively regulates glucose metabolism by engaging in glycogenesis (formation of glycogen) and glycogenolysis (breakdown of glycogen into glucose). Additionally, it plays a crucial role in gluconeogenesis, synthesizing glucose from other compounds as needed.
- **Protein Synthesis:** The liver is a major hub for protein synthesis, generating various proteins, including those found in blood plasma. These proteins are essential for nutrient transport and the regulation of osmotic pressure.
- **Participation in Digestion:** Engaging in digestive processes, the liver produces bile and contributes to fat metabolism, facilitating the breakdown and absorption of fats.
- **Detoxification:** A primary function of the liver is detoxifying the blood by eliminating toxins and harmful substances. It transforms these compounds into safer forms that can be excreted from the body.
- **Bile Production:** The liver produces bile, stored in the gallbladder, and released into the intestines during digestion. Bile aids in the emulsification and digestion of fats.
- **Nutrient Storage:** Acting as a nutrient reservoir, the liver stores essential vitamins (such as A, D, E, K) and minerals. It also stores iron in the form of ferritin.
- **Regulation of Cholesterol Levels:** The liver plays a pivotal role in controlling blood cholesterol levels by synthesizing and eliminating cholesterol from the body.

Caffeine undergoes metabolism in the liver through the cytochrome P450 oxidase enzyme system, particularly the CYP1A2 enzyme. This metabolic process gives rise to three primary metabolites: paraxanthine (84%), theobromine (12%), and theophylline (4%). Additionally, another enzyme, NAT2, plays a role in the elimination of caffeine by catalyzing the transformation of various foreign chemical substances within the body [17].

An expanding body of evidence suggests that coffee consumption exerts a positive influence on the development and progression of various liver diseases. Clinical studies have substantiated the benefits of coffee consumption in conditions such as hepatitis B and C, non-alcoholic fatty liver disease, alcoholic liver disease, as well as liver fibrosis and cirrhosis, as demonstrated by the research conducted by Wadhawan and Ananda in 2016 [18]. Similarly, the study by Liu et al. in 2015 focusing on liver fibrosis and cirrhosis underscored the advantageous effects associated with coffee consumption [19].

Both meta-analyses unequivocally indicate that consuming more than 2 cups of coffee per day among individuals with existing liver disease is correlated with a diminished risk of developing liver fibrosis and cirrhosis. Additionally, this level of coffee consumption is associated with a lower risk of hepatocellular carcinoma and cancer, as well as reduced mortality. Reinforcing these positive outcomes, two recent population-based studies, NHANES I and III [20,21], revealed that higher coffee intake (exceeding 2 cups per day) was linked to a 44% reduction in the risk of elevated ALT levels and a decreased likelihood of chronic liver disease compared to non-coffee drinkers.

In a recent extensive cohort study [22] involving 330 patients diagnosed with both alcoholic and non-alcoholic cirrhosis, a robust inverse relationship was identified between coffee consumption (exceeding 4 cups per day) and elevated blood enzyme levels, particularly among those with substantial alcohol intake. Furthermore, the study revealed that coffee consumption contributes to a reduction in liver stiffness, indicating a potential decrease in the occurrence of fibrosis and inflammation in individuals affected by non-alcoholic fatty liver disease, as well as hepatitis C and B virus infections [23].

While the association between coffee consumption and a decreased risk of liver disease is evident, the specific contribution of caffeine versus other components of coffee to this effect remains uncertain.

IVe. How does the coffee we consume affect the last segment of the digestive tract?

The intestine is a crucial segment of the digestive tract, facilitating the absorption of substances resulting from food digestion under enzymatic influence. In humans, the intestine comprises two primary parts: the small intestine and the large intestine. The small intestine, encompassing the duodenum, jejunum, and ileum, is primarily responsible for digestion and

nutrient absorption. On the other hand, the large intestine consists of the cecum, ascending colon, transverse colon, descending colon, sigmoid colon, rectum, and anus.

The small intestine is instrumental in the digestion and absorption of nutrients, while the large intestine focuses on additional water absorption, fermentation, and the formation of fecal mass. Both organs play pivotal roles in maintaining a healthy digestive system and overall bodily equilibrium.

The efficient functioning of the colon is especially significant for ensuring regular bowel movements and preventing issues such as diarrhea or constipation.

Caffeinated coffee appears to enhance colonic motility more effectively than decaffeinated coffee and water, reaching levels comparable to those observed post-meal consumption. However, the degree of this impact may vary among individuals. Recent research indicates that even decaffeinated coffee can stimulate motility, with a noticeable increase in colon motility observed just four minutes after consuming coffee [15]. This suggests that coffee intake promotes intestinal peristalsis, facilitates bowel movements, and helps prevent constipation.

A study involving 454 teenagers suggests that coffee consumption is a significant risk factor associated with irritable bowel syndrome (IBS) in adolescents aged 14-18. The research identified coffee consumption as one of the key factors contributing to the elevated risk of IBS among surveyed adolescents. The primary risk factors for IBS included female gender, incidents of bullying, age between 14-16, history of constipation and diarrhea, as well as the consumption of nuts, coffee, tea, and carbonated drinks.

While the study didn't delve into the detailed mechanisms through which coffee affects IBS, it underscores a statistically significant correlation between coffee consumption and the occurrence of irritable bowel syndrome in adolescents. As a result, individuals experiencing IBS symptoms may find benefit in reducing their coffee intake to enhance overall quality of life and gut health [24].

A noteworthy aspect linked to coffee consumption revolves around its potential role in restoring normal digestive tract function post-surgery. Following abdominal surgeries, such as colorectal or gynecological procedures, gastrointestinal functions often experience a slowdown. Coffee consumption has been suggested as a beneficial factor in expediting the

recovery of the digestive tract in patients. This could potentially lead to a shorter duration until the first defecation and enhanced tolerance to solid foods [15, 25].

IVf. Coffee has a positive effect on the intestinal micro biota

A burgeoning field in nutritional research revolves around comprehending the interplay between gut microbiota, dietary patterns, and overall health. Studies suggest that coffee consumption supports the proliferation of Bifidobacterium spp. bacteria in the intestines [21, 26, 27]. The dietary fiber found in coffee can undergo conversion into short-chain fatty acids, fostering the growth of key bacterial species that dominate the intestinal flora. Moreover, the polyphenols in coffee, notably chlorogenic acid, may confer beneficial effects on the gut microbiota [26, 27].

Ongoing research into the influence of food and beverage intake on gut microbiota dynamics is a rapidly evolving field. With a focus on the intricate relationships between coffee consumption and the gut microbiota, new insights continue to emerge systematically.

IVg. Is there a potential link between coffee consumption and cancer risk?

In a 2016 report, the International Agency for Research on Cancer (IARC) concluded that there is insufficient evidence to confirm any link between coffee consumption and the occurrence of gastrointestinal cancers, such as cancer of the mouth, throat, larynx, stomach, esophagus, or colon. The data analyzed by IARC also did not indicate a link between coffee drinking and an increased risk of pancreatic cancer. Furthermore, an IARC review suggested that coffee consumption was associated with a reduced risk of liver cancer [15].

V. Conclusions

Given the widespread global consumption of coffee, comprehending its impact on the gastrointestinal tract and related organs during ingestion is crucial. However, research in this area remains relatively limited. An examination of the available data reveals that coffee intake stimulates the secretion of gastric, bile, and pancreatic juices, contributing to the early phases of the digestive process. While there is limited evidence supporting a direct effect of coffee on gastroesophageal reflux disease, it appears more likely to be a consequence of a combination of other risk factors such as obesity and an unhealthy diet.

Furthermore, coffee has been found to enhance the motor activity of the large intestine, and its consumption is increasingly suggested as a benign adjunct in expediting the recovery of colon function following abdominal surgery. Coffee consumption also influences the composition of the intestinal microbiota, particularly by impacting the populations of Bifidobacteria, Bacteroides, and Prevotella. No adverse effects of coffee consumption on various gastrointestinal organs have been reported; instead, its protective benefits against liver cancer and other liver diseases are consistently documented.

Nevertheless, further research is warranted, especially considering that existing data predominantly stem from the 1990s and earlier, exhibiting variations due to differences in coffee type, processing, concentration, and preparation methods. It is advisable to conduct additional prospective studies utilizing modern technologies and encompassing larger and more diverse population groups for a comprehensive understanding of coffee's effects on gastrointestinal health.

DISCLOSURE

Author's contribution:

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All authors have read and agreed with the published version of the manuscript.

Funding Statement: The Study Did Not Receive Special Funding.

Institutional Review Board Statement: Not Applicable.

Informed Consent Statement: Not Applicable

Data Availability Statement: Not Applicable.

Conflict Of Interest: The authors declare no conflict of interest.

List of figures:

Figure 1. The chemical structure of the coffee ingredient – caffeine [4]

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