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Review

Assessing the Validity of Bulletproof Coffee's Claims

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Abstract: 'Bulletproof Coffee', a popular beverage composed of coffee, grass-fed butter, and medium-chain triglyceride oil, has gained significant attention for its purported benefits including cognitive enhancement, increased alertness and energy, appetite suppression, and improved metabolic outcomes. However, the scientific evidence supporting these claims remains limited. This review aims to evaluate the evidence and determine the validity of claims regarding Bulletproof Coffee. Studies published between 2010–2023 were retrieved and evidence pertaining to cognition, alertness and energy, hunger and satiety, serum cholesterol, and gastrointestinal tolerance and Bulletproof Coffee were evaluated. The findings suggest that the current evidence base is small, and overall, there is weak or insufficient evidence to support the claimed benefits of Bulletproof Coffee. In particular, there were no significant improvements in cognition, alertness, or energy levels from Bulletproof Coffee compared to regular coffee. The impact on hunger, satiety, resting energy expenditure, and fat oxidation appeared equivocal, with effects offset by the additional calorie intake of Bulletproof Coffee. Further research with more rigorous study designs, larger sample sizes, diverse populations, and standardized methodologies are required in addition to an examination of potential health risks associated with regular Bulletproof Coffee consumption.

Keywords: Bulletproof Coffee; butter coffee; MCT; medium-chain triglyceride oil; cognitive function; alertness; energy; hunger; satiety; narrative review

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1. Introduction

Cardiovascular disease (CVD) stands as the leading cause of worldwide mortality [1]. Research has firmly established a connection between elevated levels of total cholesterol and LDL cholesterol, and the occurrence of CVD [2]. Diet, particularly the intake of saturated fat, plays a significant role in modulating these cholesterol levels [3]. Consequently, minimizing saturated fat consumption has become an internationally accepted strategy to mitigate CVD risk [4]. However, the promotion of foods and beverages high in saturated fats persists [5,6], leading to three quarters of American adults surpassing recommended intakes [7].

Butter coffee is an increasingly popular beverage, with a valuation of USD 90 billion in 2022 that is forecast to reach USD 138 billion by 2032 [8]. Bulletproof Coffee is a form of butter coffee that consists of ground coffee with added fat in the form of grass-fed butter and medium-chain triglyceride (MCT) oil [9]. The beverage was intended to replace a meal at breakfast and is often included in the diets of people who follow low-carbohydrate (including ketogenic) diets [10]. One cup (237 mL) contains 230 calories, 25 g total fat, 21 g saturated fat, 0 g carbohydrates, and 0 g protein [11]. Numerous claims have been attributed to Bulletproof Coffee including heightened focus and energy, reduced hunger and cravings, fat burning, and an overall productivity boost surpassing that of conventional coffee [9,12,13]. There are several mechanisms by which these benefits are proposed to accrue [9]. Polyphenols in coffee are proposed to increase focus and memory. Grass-fed butter is described as a rich source of conjugated linoleic acid and butyrate, which are claimed to increase fat oxidation and enhance brain function, respectively. The dietary fats

in butter are also proposed to slow the absorption and sustain the release and bioavailability of caffeine. Lastly, MCT oil is proposed to increase blood levels of ketone bodies, which enhances brain function and fat oxidation.

Survey data from a recent study of 210 American college students demonstrate the pervasiveness of beliefs in the legitimacy of claims surrounding Bulletproof Coffee. More than half of survey respondents believed that the beverage promotes fat loss, enhances concentration, decreases stress levels, and increases energy. An additional 20 percent remained unsure, demonstrating the pressing need for a comprehensive scientific examination of Bulletproof Coffee to provide consumers with accurate information [14]. Similarly, Google Trends data indicate that the term "Bulletproof Coffee" remains of interest since its peak in 2018 [15].

Review Scope

Given the potential health implications of habitually consuming this high-saturated fat beverage, understanding the scientific foundation underlying the purported benefits of Bulletproof Coffee becomes critically important. This narrative review therefore aims to summarize the existing body of evidence regarding Bulletproof Coffee. In doing so, the review will equip healthcare professionals with the necessary information to offer informed recommendations and assist consumers in making educated decisions about Bulletproof Coffee consumption based on the available scientific evidence.

2. Materials and Methods

2.1. Literature Search

This narrative review searched for research on the effects of Bulletproof Coffee on outcomes relating to product claims. Although this is a narrative review, the source articles were identified using a systematic search strategy. The online databases MEDLINE (PubMed) and Google Scholar were searched from 2010 to August 2023 for eligible studies. Key search terms, including MeSH terms, were determined in accordance with the PICO method: "human subjects" for participants; "Bulletproof Coffee", "butter coffee", and "medium-chain triglycerides coffee" for interventions; and "cognition", "alertness", "energy", "hunger", "satiety", "resting energy expenditure", and "fat oxidation" for outcomes. All PubMed results and the first 200 Google Scholar results for each keyword search were reviewed.

2.2. Study Eligibility and Selection

Studies were considered eligible if they: (1) were interventional studies or case reports, (2) were published in scientific journals, as dissertations, or as conference abstracts, (3) included human subjects, and (4) included outcome measures pertaining directly to claims made in Bulletproof books or the company website (i.e., cognition, alertness, energy, hunger, satiety, energy expenditure, fat oxidation). Studies were excluded if they: (1) were narrative reviews, (2) did not include both coffee and a source of concentrated fatty acids (i.e., ghee, butter, medium-chain triglycerides) in the experimental group, (3) were conducted in populations with cognitive diseases (e.g., dementia) or diseases known to affect metabolic rate (e.g., Hashimoto's thyroiditis), (4) only included outcome measures unrelated to claims made in Bulletproof books or the company website (i.e., cellular inflammation), or (5) were unavailable in the English language.

Preliminary screening was completed in duplicate by reviewing the titles and abstracts to assess eligibility by researchers DG and MQ. Studies not meeting the inclusion criteria were excluded. Full text articles were reviewed in duplicate by DG and MQ.

2.3. Data Extraction and Synthesis

Methodology characteristics and outcomes were extracted from eligible studies. Extracted data included subject characteristics (age range and baseline coffee consumption), dietary provisions in the experimental and control groups (if a control group was included),

outcomes (cognition, alertness, energy, hunger, satiety, resting energy expenditure, fat oxidation), and the methods used to measure outcomes (cognitive assessments, subjective measures, indirect calorimetry). Effects in identified themes were reviewed in a narrative synthesis.

3. Results

Following the literature search 204 articles were identified. After excluding 198 articles (18 duplicates, 155 that did not investigate both coffee and ghee, butter, or medium chain triglycerides, 23 that did not present original data, and two that exclusively measured variables impertinent to Bulletproof Coffee claims), six articles met the inclusion criteria and were included in the final synthesis. Figure 1 illustrates the selection process. A narrative analysis of these studies presented six key themes (Table 1), and results are classified in accordance with these themes.

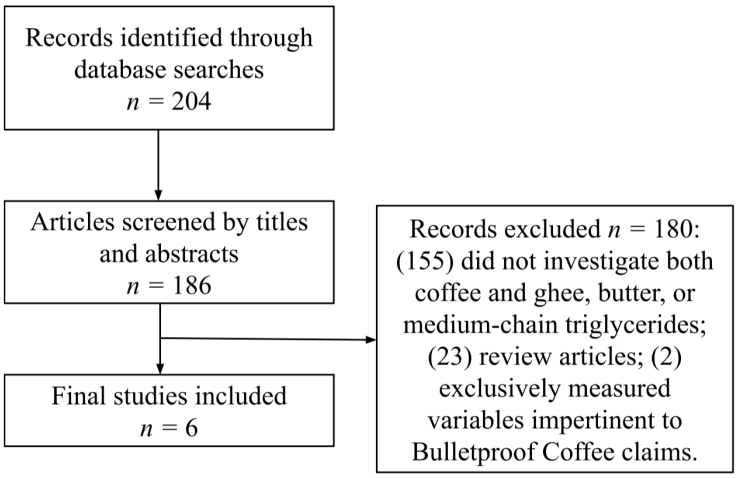

Figure 1. Article selection process.

3.1. Cognition

The effects of Bulletproof Coffee on cognitive function were investigated in two randomized interventional trials (Table 1). Crampton et al. conducted a single-blind, randomized crossover design to explore the acute effects of Bulletproof Coffee on cognitive performance. The study included six healthy, coffee-drinking participants. On two separate occasions, separated by a seven-day washout period, subjects consumed either 10 ounces (296 mL) of Bulletproof Coffee or regular black coffee equivalent to 114 mg caffeine in both conditions. Cognitive performance was evaluated through the Digit Substitution Task (DSST), at baseline and at 60- and 170-min post-consumption. The findings suggested no significant differences in cognitive function, as gauged by the number of correct responses on the DSST, between the Bulletproof Coffee and black coffee conditions [16].

Bergauer et al. led another investigation that used a double-blind, placebo-controlled, crossover design to explore the effects of Bulletproof Coffee on cognition. The study included 21 regular coffee-drinking healthy undergraduate students who consumed 1–4 cups of coffee daily. On separate testing days, participants ingested either Bulletproof Coffee, regular coffee, or decaffeinated coffee, estimated to contain 80 ± 10 mg/100 mL, 80 ± 10 mg/100 mL, and 3 ± 10 mg/100 mL of caffeine, respectively, with wash-out periods of at least 4–5 days between sessions. Cognitive performance was assessed 45 min after coffee administration in 96-min testing sessions that included two working memory-related tasks: the immediate and delayed spatial memory task (SMT) and the N-back task. The results showed no superior performance in cognitive tasks for participants consuming Bulletproof Coffee compared to those consuming regular or decaffeinated coffee [17]. The authors nonetheless address that caffeine demonstrates potential to enhance performance by exerting stimulatory effects on the central nervous system (CNS).

Table 1. Studies examining the effects of Bulletproof or butter coffee on outcomes related to company claims, health, and gastrointestinal tolerance.

Author (Year)	Design	Participants (*n*); Age (Range)	Duration	Baseline Coffee Intake	Intervention	Control	Measurements	Results
Crampton (2021) [16]	R, SB, C, CO	6; 17–33	2 visits with 7~-day washout period	"regular coffee consumers" (details NR)	15 mL MCT oil, 15 mL grass-fed ghee, 296 mL caffeinated coffee	296 mL black coffee	Cognitive performance, hunger, and satiety	No significant difference in cognitive performance; Significant increase in fullness for Bulletproof Coffee compared with black coffee
Bergauer (2021) [17]	R, DB, C, CO	21; "Second year bachelor students" (details NR)	3 visits with at least 4–5-day washout periods	237–946 mL/day	1 T grass-fed butter, 1 T MCT oil, black coffee providing 190 +/− 10 mg caffeine/237 mL	(1) Dark roast coffee providing 190 +/− 10 mg caffeine/237 mL, 0.5 t grass-fed butter; (2) Decaffeinated coffee providing 3 mg caffeine/100 mL, 0.5 t grass-fed butter	Spatial memory, working memory, mood including alertness, contentedness, and calmness	No significant difference in memory or mood dimensions Significant increase in alertness for decaffeinated coffee condition; Significant decrease in alertness for regular coffee condition; Significant interaction effect for placebo and regular coffee conditions
Fritchen (2016) [18]	R, DB, C, CO	12; 20–25	2 visits with 7-day or shorter washout period	Equivalent to 226–426 mg/day of caffeine	4 mg caffeine/kg body weight in the ratio 1 T grass-fed butter:1 T MCT oil:355 mL black coffee	4 mg caffeine/kg body weight from black coffee	Alertness, satiety, resting energy expenditure and fat oxidation, gastrointestinal tolerance	Significant increase in alertness in both conditions; No significant difference in alertness between groups; Significant increase in satiety in Bulletproof Coffee condition; Nonsignificant decrease in satiety in black coffee condition; Difference between groups NR; Significant increase in REE and RQ in Bulletproof Coffee condition; Significant decrease in RQ in Bulletproof Coffee condition; No significant difference in REE or RQ in black coffee condition; Difference in REE and RQ between groups NR; Increase in gastrointestinal intolerance scores in Bulletproof Coffee condition; No difference in gastrointestinal scores in black coffee condition

Table 1. *Cont.*

Author (Year)	Design	Participants (*n*); Age (Range)	Duration	Baseline Coffee Intake	Intervention	Control	Measurements	Results
Baumeister (2021) [19]	DB, C, CO	7; 22–29	10 visits with 24-h washout periods	NR	(1) 10 mL tricaprylin, 150 mg caffeine, 250 mL decaffeinated coffee; (2) 10 mL tricaprylin, 250 mL decaffeinated coffee; (3) 10 mL tricaprin, 150 mg caffeine, 250 mL decaffeinated coffee; (4) 10 mL tricaprin, 250 mL decaffeinated coffee; (5) 5 mL tricaprylin, 5 mL tricaprin, 150 mg caffeine, 250 mL decaffeinated coffee; (6) 5 mL tricaprylin, 5 mL tricaprin, 250 mL decaffeinated coffee; (7) 10 mL coconut oil, 150 mg caffeine, 250 mL decaffeinated coffee; (8) 10 mL coconut oil, 250 mL decaffeinated coffee	(1) 150 mg caffeine, 250 mL decaffeinated coffee; (2) 250 mL decaffeinated coffee	Sensory; Hunger, satiety, side effects	Increase in hunger and decrease in satiety in all conditions; Most common side effects were difficulty concentrating, abdominal pain, nausea, headache; Abdominal symptoms were most common in oil-based conditions
McAllister (2020) [20]	R, DB, C, CO	10; "College-aged" (details NR)	3 visits; Washout period NR	237–473 mL/day	(1) 21 g MCT oil, 7 g coconut oil, stevia-based sweetener (quantity NR), 473 mL caffeinated coffee; (2) 31.5 g MCT oil, 10.5 g coconut oil, stevia-based sweetener (quantity NR), 473 mL caffeinated coffee	Stevia-based sweetener (quantity NR), 473 mL black coffee	TC, HDL-c, TG	Significant increase in TC, HDL-c in all conditions, no difference between groups; Significant decrease in TG in all conditions, no difference between groups
Toklu (2015) [21]	CR	1; 59 y	"Several months"; further details NR	NR	1–2 cups per day of Bulletproof Coffee (2 T unsalted grass-fed butter, 1 T MCT oil, 1–2 cups coffee)	None	TC, LDL-c, HDL-c, TG, non-HDL-c	Increase in TC, LDL-c, Non-HDL-c; Decrease in TG following Bulletproof Coffee

C—Controlled; CO—Crossover; CR—Case report; DB—Double blind; Gastrointestinal—GI; HDL-c—High-density lipoprotein-cholesterol; kg—Kilograms; LDL-c—Low-density lipoprotein-cholesterol; MCT—Medium-chain triglycerides; mg—Milligrams; NR—Not reported; R—Randomized; RQ—Respiratory quotient; REE—Resting energy expenditure; SB—Single blind; T—Tablespoon; t—teaspoon; TC—Total cholesterol; TG—Triglycerides.

3.2. Alertness and Energy

Several trials have explored the potential impact of Bulletproof Coffee on subjective perceptions of alertness and energy. Bergauer et al. utilized the Bond & Lader questionnaire to measure several dimensions of mood including alertness, contentedness, and calmness, both before and after coffee consumption. There were no significant effects from either Bulletproof Coffee, regular coffee, or decaffeinated coffee on any mood dimension. However, a significant increase in alertness was observed post-consumption of the placebo drink, and a significant decrease in alertness was noted after the ingestion of regular coffee. A significant interaction effect was detected between coffee condition and time point (pre- and post-test) for the placebo and regular coffee condition, but not for the Bulletproof Coffee condition [17].

In a separate study, Fritchen investigated the influence of Bulletproof Coffee on alertness using a randomized, double-blind, crossover design. Twelve healthy undergraduate students who habitually consumed coffee were instructed to eat a standardized meal 12 h before testing, followed by a 12-h fasting period. Baseline alertness was assessed using a five-point Likert scale questionnaire. During the testing session, participants had 20 min to consume either Bulletproof Coffee or regular black coffee, each providing 4 mg caffeine/kg of body weight, and the procedure was repeated with the other coffee condition within a seven-day period. Subsequent to metabolic assessments (discussed later), participants completed the questionnaire again 60 min post-consumption. The data revealed significant increases in alertness scores from pre- to post-consumption for both Bulletproof Coffee and black coffee. No significant differences in score changes were identified between the two testing conditions [18]. The results suggest that heightened alertness is primarily linked to the caffeine content in coffee, which the authors describe is a common byproduct of the role caffeine plays as a CNS stimulant.

Bulletproof Coffee typically consists of a blend of coffee, grass-fed butter, and MCTs, but is frequently consumed merely as coffee with MCTs or coconut oil [19]. In a controlled, double-blind trial by Baumeister et al., seven young, healthy participants underwent a 12-h fasting period prior to the testing session. During the intervention, participants consumed 10 mL of three MCT mixtures or coconut oil, either with or without 150 mg of caffeine, in 250 mL of decaffeinated coffee. This was conducted over ten sessions, each separated by 24-h washout periods. Subjective perceptions of energy levels were assessed through questionnaires given during coffee ingestion and again 240 min post-testing. The ingestion of the test solutions did not result in increased energy or activity [19].

3.3. Hunger and Satiety

Bulletproof Coffee has been claimed to reduce hunger and assist with satiety [12]. One randomized, double-blind, crossover trial conducted by Fritchen assessed satiety levels through questionnaires administered at baseline and 60-min post-ingestion. Participants indicated significantly enhanced levels of satiety on a five-point Likert scale questionnaire following consumption of Bulletproof Coffee (0.875 ± 0.31; $p < 0.05$). In contrast, feelings of satiety declined in the black coffee condition, but this change was not statistically significant (0.417 ± 0.30; $p > 0.05$). Differences between Bulletproof Coffee and regular coffee were not determined [18].

Crampton et al. measured satiety in a randomized, single-blind, crossover design trial. Hunger and fullness were assessed by questionnaire at baseline in a fasted state and 60- and 170-min post-consumption of Bulletproof Coffee and black coffee. A significant condition by time interaction was observed, resulting in increased measurements of fullness ($p = 0.04$) and reductions in perceived prospective food consumption ($p = 0.02$) in the Bulletproof Coffee condition compared to black coffee [16].

Satiety was also measured in another double-blind randomized controlled intervention. The questionnaire was administered before and 240 min after Bulletproof Coffee consumption. The questionnaire consisted of six items on hunger and satiety that were

evaluated using a 10-point scale. Participants reported elevated levels of hunger at the start of the intervention due to the overnight fast (min 3 ± 3.1; max 5.29 ± 2.98 mean values not provided), and all interventions resulted in increased hunger (min 6.17 ± 1.84; max 8.43 ± 1.13 mean values not provided) and diminished satiety (data not provided). No significant differences in satiety were apparent between the Bulletproof Coffee and regular coffee groups [19].

3.4. Resting Energy Expenditure and Fat Oxidization

Fritchen et al. conducted a randomized, double-blind, crossover trial to explore the acute metabolic effects of Bulletproof Coffee. Following a 12-h overnight fast and ingestion of a standardized test meal, baseline metabolic measurements were recorded using indirect calorimetry. Subsequently, participants consumed either Bulletproof or black coffee, each supplying 4 mg caffeine/kg of body weight and metabolic measurements were repeated immediately, as well as at 30- and 60-min intervals. The results indicated a significant interaction between time and condition for resting energy expenditure (REE; $p = 0.003$), with an increase observed in both conditions. Notably, only the Bulletproof Coffee condition demonstrated a statistically significant elevation in REE, increasing from a baseline value of ~1665 kcal/day by 207 ± 76 kcal/day at 30 min and 224 ± 77 kcal/day at 60 min post-consumption ($p < 0.05$). Additionally, a significant interaction effect was observed for fat oxidation rates in the Bulletproof Coffee condition, as indicated by a significant decrease in respiratory quotient (RQ) at 30 and 60 min (−0.077 ± 0.015 and −0.068 ± 0.015, respectively; $p = 0.003$). No significant changes in RQ were observed after consuming black coffee, and between-group differences for REE and RQ were not analyzed [18].

3.5. Serum Cholesterol

McAllister et al. conducted a randomized, double-blind crossover trial that measured the effects of coffee with varying amounts of MCT oil on total cholesterol and HDL-c. Ten men with no known history of cardiometabolic disorders who habitually consumed 8–16 ounces/day (237–473 mL/day) of coffee underwent an ≥8 h fast prior to testing sessions. On three separate days, participants ingested 16 ounces (473 mL) of freshly brewed black coffee with stevia as the sweetener and no added lipids, 28 g lipids, and 42 g lipids. Caffeine content was estimated as 100–200 mg for all conditions. Lipids consisted of 75% MCT oil and 25% coconut oil. Participants were allowed 15 min to finish the beverage and blood samples were collected at pre- 120 min post- and 240 min post-prandial. The four-hour area under the curve (AUC) for total cholesterol was 777.1 ± 91.0, 776.7 ± 125, and 814.8 ± 66.3 mg/dL following consumption of the 0, 28, and 42 g MCT-containing beverages respectively. The AUC for HDL-c was 225.6 ± 61.8, 253.7 ± 68.5, and 263.3 ± 78.3 mg/dL. Differences in total cholesterol reached statistical significance between the 0 g and 28 g lipids conditions ($p = 0.03$) and 0 g and 42 g lipids conditions ($p = 0.02$). Differences in HDL-c also reached statistical significance between the 0 g and 28 g lipids conditions ($p < 0.003$) and 0 g and 42 g lipids conditions ($p < 0.001$). LDL-c was not measured [20].

A case report has also been published involving a 59-year-old male with dyslipidemia who experienced a notable rise in serum lipids after incorporating Bulletproof Coffee into his dietary regimen. Upon discontinuation of rosuvastatin, the patient's lipid levels nearly doubled (total cholesterol: 138 to 215 mg/dL; LDL-c: 84 to 156 mg/dL; HDL-c: 43 to 44 mg/dL). Serum cholesterol measurements were then repeated, after which he began consuming one to two cups of Bulletproof Coffee daily. Over several months, while maintaining a consistent exercise regimen, his lipid profile deteriorated further (total cholesterol: 215 to 285 mg/dL; LDL-c: 156 to 232 mg/dL; HDL-c: 44 to 48 mg/dL), leading to the recommendation to cease consumption [21].

3.6. Gastrointestinal Tolerance

Gastrointestinal intolerance has been reported with consumption of Bulletproof Coffee. Fritchen et al. evaluated gastrointestinal tolerance using a Likert scale after participants consumed Bulletproof or black coffee. Results suggested a significant increase in gastrointestinal intolerance scores (-1.33 ± 0.21; $p < 0.05$) following ingestion of Bulletproof Coffee, which included 22–61 g of total fat, an effect not observed with black coffee, which included 0 g of total fat. Notably, several participants ($n = 5$) reported difficulty relaxing during the test due to gastrointestinal intolerance. Similarly, Baumeister et al. evaluated gastrointestinal tolerance by administering questionnaires to participants 240 min after consuming either Bulletproof or black coffee [19]. The questionnaires indicated that side effects such as abdominal pain ($n = 7$) and nausea ($n = 7$) were most common with Bulletproof Coffee consumption, which is estimated to contain 9 g of total fat. It is noteworthy that participants generally rated the perceived acidity of the beverages higher when consuming Bulletproof Coffee [18].

4. Discussion

This narrative review evaluated the existing scientific evidence pertaining to Bulletproof Coffee, a high-saturated fat, caffeinated beverage. Popular claims about this product suggest it is associated with cognitive enhancement, heightened energy levels, and satiety benefits. However, the scientific evidence does not support these claims. From a very small evidence base, we found there were no significant improvements in cognition, alertness, or energy levels from Bulletproof Coffee consumption compared with regular coffee. The effects of Bulletproof Coffee on hunger, satiety, resting energy expenditure, and fat oxidation were equivocal and likely due to the increased caloric load accompanying its consumption. There is also evidence of possible elevations in serum cholesterol and gastrointestinal intolerance following consumption of Bulletproof Coffee.

In the cognitive domain, studies by Crampton et al. [16] and Bergauer et al. [17] do not support the purported benefits of Bulletproof Coffee compared to regular or decaffeinated coffee. These findings correspond with previous research that has not consistently demonstrated the efficacy of caffeine in enhancing memory [22], a critical domain of cognition. Nevertheless, the limited sample sizes and narrow array of cognitive measures employed in these studies may restrict the generalizability of results. Future research employing more rigorous study designs, larger sample sizes, diverse demographic groups, and a broader array of cognitive measures is warranted to fully elucidate the potential impact of Bulletproof Coffee on cognition.

The impact of Bulletproof Coffee on subjective alertness and energy was divergent between studies. Bergauer et al. [17] found no significant impact of Bulletproof Coffee on mood dimensions such as alertness. Moreover, results indicated an unexpected rise in alertness following placebo consumption, suggesting the possible interplay of expectancy effects or other psychological factors. Results could have been influenced by the timing of the mood assessment, given that the effects of caffeine typically peak ~45 min after ingestion [19], while the Bond & Ladder questionnaire post-measurement was taken 95 min post-consumption. Furthermore, the cognitive tasks executed during the testing procedure may have affected mood ratings. Conversely, results from Fritchen [18] indicated significant elevations in alertness approximately 60 min subsequent to the ingestion of both Bulletproof Coffee and regular black coffee. Perceived increases in alertness may have arisen from the caffeine content, which was consumed with greater temporal proximity to assessments. Research from Baumeister et al. [19] did not produce subjective increases in energy levels regardless of the presence or absence of caffeine or dietary fat in coffee beverages. Post-ingestion measurements were collected 240 min post-ingestion which, similar to the study by Bergauer et al. [17], is outside the window of peak effect for caffeine [23]. Collectively, these studies indicate the need for a more rigorous and standardized methodological approach, incorporating precise timing of cognitive assessments and

controlling for potential confounding variables such as the cognitive tasks themselves as well as psychological expectancy effects.

Bulletproof Coffee was associated with increased levels of self-reported satiety in one study [18], but this was not corroborated by subsequent research [19]. In the study by Fritchen [18], Bulletproof Coffee provisions included 1 tablespoon (15 mL) of both MCT oil and grass-fed butter per 12 ounces (355 mL) of coffee, providing 200–550 calories, and subjects indicated enhanced levels of satiety following ingestion. Baumeister et al. [19] also assessed satiety following consumption of Bulletproof Coffee. The product used in this study included decaffeinated coffee, with or without 150 mg added caffeine, with or without 10 g of MCT or coconut oil, and omitted grass-fed butter, yielding no more than 90 calories per condition. No significant differences in satiety were detected between groups. Differences in the energy provisions of beverages may have contributed to the disparate findings because the decreased calorie content might have lessened the satiating effect of the beverage. Despite robust evidence suggesting that dietary fat is the least satiating macronutrient [24], it still yields a moderate satiating effect, comparable to canola and peanut oils [25].

The only study that assessed metabolic parameters found that consumption of both Bulletproof Coffee and black coffee increased REE, but the results only reached statistical significance in the experimental condition [18]. The magnitude of this elevation is comparable to that observed following consumption of other high-fat meals [26,27], which suggests that the postprandial elevation in energy expenditure is unlikely to confer a unique advantage pertaining to energy balance. The observed increase in REE from baseline following Bulletproof Coffee consumption can likely be attributed to the additional 200–550 calories the beverage provided from dietary fat, since caffeine content relative to body mass was matched between conditions. The additional calories consumed from dietary fat in Bulletproof Coffee are likely to offset the observed increase in REE. Previous research has demonstrated that high-fat meals and beverages can increase REE in healthy individuals, with higher polyunsaturated fatty acid (PUFA) contents yielding larger increases compared to meals rich in saturated fatty acids (SFAs) [28,29]. Similar increases in REE have been observed with high-carbohydrate meals [30–32], suggesting that butter and MCT oil in Bulletproof Coffee may not play a unique role in elevating postprandial metabolic rate. The lack of a significant difference in REE with black coffee consumption is unexpected, given prior research indicating a 3–4% increase in REE with a 100 mg caffeine dose [33]. Considering that participants in the study by Fritchen consumed over twice this dosage (~220–440 mg caffeine) [18], further research is needed to determine factors influencing the impact of coffee and caffeine on REE. Potential factors may include variations in individual responses and other underlying mechanisms modulating the thermogenic effects [34].

The only trial that examined substrate utilization following coffee consumption found that Bulletproof Coffee, but not black coffee, produced significant increases in fat oxidation rates [18]. Studies comparing substrate utilization after consuming meals or beverages high in SFAs or PUFAs do not show significant differences in fat oxidation [28,29], indicating that alternative sources of unsaturated fats (e.g., soymilk, almond milk) could be used in coffee preparation if increased fat oxidation and lower saturated fat intake is desired. It is important to highlight, however, that elevated rates of fat oxidation do not necessarily lead to a larger body fat reduction [35], emphasizing the complexity of weight management. The absence of significant differences in fat metabolism with black coffee may be attributed to insufficient caffeine dosage and the chosen measurement modality. While all participants consumed 4 mg of caffeine per kilogram of body weight (mg/kg) [18], a recent meta-analysis on caffeine consumption and fat metabolism indicated that a dosage of 5.7 mg/kg produces a small effect size on fat metabolism when analyzed using expired gas analysis (e.g., respiratory exchange ratio, calculated fat oxidation) (effect size = 0.26, 95% CI [0.16, 0.37]) [36]. Notably, caffeine seems to exert a greater impact on fat metabolism ($p < 0.001$) when evaluated through blood biomarkers (e.g., free fatty acids, glycerol) (effect size = 0.55, 95% CI [0.43, 0.67]) [36]. Further research is warranted to explore the effects of Bulletproof

Coffee on endpoints that are more consequential to weight management, including body weight and body composition.

Serum total- and HDL-cholesterol levels were shown to increase acutely following consumption of Bulletproof Coffee prepared with MCT oil [20]. These findings correspond with previous research showing that acute coffee ingestion increases total cholesterol and HDL-c levels to a statistically but not clinically significant extent, due the cholesterogenic diterpene esters, cafestol and kahweol, which are naturally present in coffee bean oils [37,38]. A meta-analysis of randomized controlled trials found that MCT oil raises total cholesterol and LDL-c relative to comparators consisting predominantly of unsaturated fats, but not longer-chain SFAs [39]. Significant changes in serum lipids may therefore be attributable to a combination of caffeine and MCT oil, particularly if the MCT oil replaced dietary sources of unsaturated fat present in the baseline diets of participants.

Evidence regarding the effects of long-term Bulletproof Coffee consumption on serum cholesterol levels is limited to a case report by Toklu et al. [21], which indicated clinically significant increases in total and LDL cholesterol experienced following months of daily Bulletproof Coffee consumption. The report found 33% and 49% increases in total cholesterol and LDL-c, respectively, while HDL-c levels increased by 9% [21]. However, the clinical significance of the HDL-c change remains unclear, as diet-induced changes in HDL-cholesterol cannot be directly associated with changes in CVD risk [3]. Consequently, the American Heart Association recommends evaluating changes in LDL-c independently of HDL-c [3].

While one randomized controlled trial and one case report are not sufficient to determine causality between Bulletproof Coffee and exacerbated dyslipidemia, these findings do align with evidence between dietary fat type and hypercholesterolemia. For example, a standard cup of Bulletproof Coffee contains 1–6 teaspoons of MCT oil and 1–2 tablespoons of grass-fed butter [11]. A recent meta-analysis indicated that MCTs typically do not produce significant increases in total cholesterol or LDL-c levels [39]. Conversely, numerous controlled trials have demonstrated that dairy fat, including butter, elevates LDL-c compared to unsaturated vegetable oils [3]. It is noteworthy that the effects on blood lipids are similar whether the butter is sourced from grass-fed or conventionally-fed cows [40]. The impact of LDL-c levels on CVD risk is well established [3], and prospective observational studies indicate that substituting 5% of total daily calories from dairy fat with PUFAs for dairy fat is associated with a 24% and 25% lower risk of heart disease and stroke, respectively [41]. Given the paucity of research exploring the relationship between consumption of Bulletproof Coffee and hyperlipidemia, further research is needed. However, regular consumption of butter is associated with increased LDL and total cholesterol and should be especially limited, especially in people with a history of hypercholesterolemia [42].

Finally, gastrointestinal intolerance was associated with Bulletproof Coffee consumption in both studies that assessed this outcome [18,19]. Caffeine stimulates the gastric secretion of hydrochloric acid [43], but a potential explanation for the greater prevalence of gastrointestinal intolerance observed in Bulletproof Coffee conditions may be the high fat content. Dietary fat delays gastric emptying [44], a common cause of chronic nausea and vomiting [45]. Dietary fat can also increase intestinal permeability [46], which has been associated with self-reported gastrointestinal symptoms [47]. Such factors may contribute to the pathophysiology detailed in the clinical vignette of a 48-year-old man admitted to the hospital with abdominal pain after consuming 10 tablespoons of Brain Octane Oil, the MCT oil sold by Bulletproof Digital, Inc., providing 140 g of total fat [48]. The patient developed new onset vomiting, diarrhea, and rectal bleeding, prompting the visit to the emergency department. His symptoms resolved with hydration, and he was instructed to discontinue use of Brain Octane Oil. It is important to highlight that this patient consumed five times the recommended quantity of MCT oil in the Bulletproof Coffee recipe [9], and such severe symptoms were not reported in the controlled experiments. Nevertheless, gastrointestinal discomfort was experienced by multiple participants in both trials that assessed tolerance following Bulletproof Coffee consumption [18,19]. Further research is

warranted to elucidate the underlying factors contributing to gastrointestinal intolerance associated with Bulletproof Coffee consumption.

The existing literature on Bulletproof Coffee provides valuable insights into the claimed potential effects on cognitive performance, mood, energy levels, satiety, and metabolic parameters. A particular strength of these studies lies in their deployment of double-blind, randomized controlled designs [17–20], thereby mitigating potential biases. Another strength involves their inclusion of coffee with varied sources of SFAs such as MCT oil with grass-fed butter [17,18,21], ghee [16], or coconut oil [19,20]. This could also be a limitation however, since variable dietary provisions may produce discrepant results. Additional limitations include small sample sizes, limited demographic diversity, and constrained cognitive and metabolic assessments. Additionally, the temporal gaps between interventions and subsequent assessments may not fully capture the peak physiological and psychological effects of the components within the beverage. Of the six studies included, one was a published conference abstract and two were student theses that were unlikely to have been peer reviewed. Therefore, findings from the present studies necessitate cautious interpretation and warrant further validation.

Future investigations would benefit from comprehensive assessment batteries that extend beyond short-term outcomes. For example, research could investigate the long-term effects of Bulletproof Coffee on lipid profiles and cardiovascular health, given the preliminary findings on its influence on cholesterol levels [20,21]. More research is also needed to isolate the individual effects of Bulletproof Coffee made with specific ingredients like MCT oil and grass-fed butter on parameters such as satiety and metabolic rate. Finally, given the initial evidence of gastrointestinal intolerance [18,19], further explorations into the safety profile are crucial, especially in populations with preexisting gastrointestinal or metabolic conditions.

5. Conclusions

In conclusion, although Bulletproof Coffee remains a popular choice for many, current scientific evidence does not support the claimed benefits. While the evidence base is limited to six studies with small sample sizes, we found no significant improvements in cognition, alertness, or energy levels in studies when Bulletproof Coffee was compared with regular coffee. The alleged effects of Bulletproof Coffee on hunger, satiety, resting energy expenditure, and fat oxidation remain equivocal, primarily due to the additional calorie intake associated with the beverage offsetting any potential benefits. Additionally, the review highlights potential health concerns linked to butter, which is a major ingredient of Bulletproof Coffee. Some evidence suggests possible elevation in serum cholesterol, and gastrointestinal intolerance has been reported following consumption of Bulletproof Coffee. Future research, featuring larger sample sizes, diverse populations, and standardized methodologies, is necessary to support any health claims for Bulletproof Coffee, and to ascertain any long-term health risks associated with regular Bulletproof Coffee consumption. Exploring the impact of regular Bulletproof Coffee consumption on hydration status, kidney stones, reflux, gallstones, blood pressure, sleep quality, gastrointestinal motility, and hyperlipidemia is also required. Such research would significantly contribute to our understanding of the impacts of this beverage, informing public health recommendations and individual dietary choices.

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References

1. Naghavi, M.; Abajobir, A.A.; Abbafati, C.; Abbas, K.M.; Abd-Allah, F.; Abera, S.F.; Aboyans, V.; Adetokunboh, O.; Afshin, A.; Agrawal, A. Global, regional, and national age-sex specific mortality for 264 causes of death, 1980–2016: A systematic analysis for the Global Burden of Disease Study 2016. *Lancet* **2017**, *390*, 1151–1210. [CrossRef]
2. Arnett, D.K.; Blumenthal, R.S.; Albert, M.A.; Buroker, A.B.; Goldberger, Z.D.; Hahn, E.J.; Himmelfarb, C.D.; Khera, A.; Lloyd-Jones, D.; McEvoy, J.W. 2019 ACC/AHA guideline on the primary prevention of cardiovascular disease: A report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *Circulation* **2019**, *140*, e596–e646. [CrossRef]
3. Sacks, F.M.; Lichtenstein, A.H.; Wu, J.H.; Appel, L.J.; Creager, M.A.; Kris-Etherton, P.M.; Miller, M.; Rimm, E.B.; Rudel, L.L.; Robinson, J.G. Dietary fats and cardiovascular disease: A presidential advisory from the American Heart Association. *Circulation* **2017**, *136*, e1–e23. [CrossRef] [PubMed]
4. Brouwer, I. The public health rationale for reducing saturated fat intakes: Is a maximum of 10% energy intake a good recommendation? *Nutr. Bull.* **2020**, *45*, 271–280. [CrossRef]
5. Colby, S.E.; Johnson, L.; Scheett, A.; Hoverson, B. Nutrition marketing on food labels. *J. Nutr. Educ. Behav.* **2010**, *42*, 92–98. [CrossRef]
6. Turnwald, B.P.; Handley-Miner, I.J.; Samuels, N.A.; Markus, H.R.; Crum, A.J. Nutritional analysis of foods and beverages depicted in top-grossing US movies, 1994–2018. *JAMA Intern. Med.* **2021**, *181*, 61–70. [CrossRef] [PubMed]
7. Snetselaar, L.G.; de Jesus, J.M.; DeSilva, D.M.; Stoody, E.E. Dietary guidelines for Americans, 2020–2025: Understanding the scientific process, guidelines, and key recommendations. *Nutr. Today* **2021**, *56*, 287. [CrossRef] [PubMed]
8. Future Market Insights. Available online: https://www.futuremarketinsights.com/reports/butter-coffee-market (accessed on 21 August 2023).
9. Asprey, D. Bulletproof Coffee's Benefits: How It Supercharges Your Morning. Available online: https://www.bulletproof.com/diet/bulletproof-diet/bulletproof-coffee-benefits/ (accessed on 13 July 2023).
10. Asprey, D. The Bulletproof Diet Roadmap. Available online: https://www.bulletproof.com/diet/bulletproof-diet/the-complete-illustrated-one-page-bulletproof-diet/?irgwc=1&utm_source=impact&utm_medium=paid_affiliate&utm_campaign=10078&utm_content=Skimbit%20Ltd._Online%20Tracking%20Link_ONLINE_TRACKING_LINK&clickid= (accessed on 6 July 2023).
11. Bulletproof Staff. Bulletproof Coffee Recipe. Available online: https://www.bulletproof.com/recipes/bulletproof-diet-recipes/bulletproof-coffee-recipe/ (accessed on 30 October 2023).
12. Asprey, D. *The Bulletproof Diet: Lose Up to a Pound a Day, Reclaim Energy and Focus, Upgrade Your Life*; Clarkson Potter/Ten Speed: Berkeley, CA, USA, 2017.
13. Bulletproof Staff. 6 Common Questions about Bulletproof Coffee. Available online: https://www.bulletproof.com/diet/bulletproof-diet/6-common-questions-about-bulletproof-coffee/ (accessed on 9 June 2023).
14. Katool, H.M. College Students Fail to Identify Nutrition Misinformation on Social Media. Undergraduate Thesis, University of Mississippi, Oxford, MS, USA, 2022.
15. Google Trends. "Bulletproof Coffee". Available online: https://trends.google.com/trends/explore?date=today%205-y&q=bulletproof%20coffee&hl=en (accessed on 6 July 2023).
16. Crampton, K.; Jackson, G.; Streight, H.; Little, J. Investigating the Effects of a High-Fat Coffee Beverage Containing Medium-Chain Triglyceride Oil and Ghee on Cognitive Function and Measures of Satiety. *Curr. Dev. Nutr.* **2021**, *5*, 902. [CrossRef]
17. Bergauer, A.; Niekerken, L.; Visser, T.F.; Noa, K.; Meng, A.; Varsamis, A. Bulletproof Coffee and Cognition. *Maastricht Stud. J. Psychol. Neurosci.* **2021**, *9*, 37–58.
18. Fritchen, J. Acute Metabolic Effects of Bulletproof Coffee. Ph.D. Thesis, University of Wisconsin, Madison, WI, USA, 2016.
19. Baumeister, A.; Gardemann, J.; Fobker, M.; Spiegler, V.; Fischer, T. Short-Term Influence of Caffeine and Medium-Chain Triglycerides on Ketogenesis: A Controlled Double-Blind Intervention Study. *J. Nutr. Metab.* **2021**, *2021*, 1861567. [CrossRef]
20. McAllister, M.J.; Waldman, H.S.; Rentería, L.I.; Gonzalez, A.E.; Butawan, M.B.; Bloomer, R.J. Acute coffee ingestion with and without medium-chain triglycerides decreases blood oxidative stress markers and increases ketone levels. *Can. J. Physiol. Pharmacol.* **2020**, *98*, 194–200. [CrossRef]
21. Toklu, B.; Milne, V.; Bella, M.; Underberg, J.A. Rise in Serum Lipids After Dietary Incorporation of "Bulletproof Coffee". *J. Clin. Lipidol.* **2015**, *9*, 462. [CrossRef]
22. Nehlig, A. Is caffeine a cognitive enhancer? *J. Alzheimers Dis.* **2010**, *20*, S85–S94. [CrossRef]
23. Institute of Medicine; Committee on Military Nutrition Research. *Caffeine for the Sustainment of Mental Task Performance: Formulations for Military Operations*; National Academy Press: Washington, DC, USA, 2001.
24. Astrup, A.; Ryan, L.; Grunwald, G.K.; Storgaard, M.; Saris, W.; Melanson, E.; Hill, J.O. The role of dietary fat in body fatness: Evidence from a preliminary meta-analysis of ad libitum low-fat dietary intervention studies. *Br. J. Nutr.* **2000**, *83*, S25–S32. [CrossRef]
25. Alfenas, R.C.; Mattes, R.D. Effect of fat sources on satiety. *Obes. Res.* **2003**, *11*, 183–187. [CrossRef] [PubMed]

26. Petzke, K.J.; Klaus, S. Reduced postprandial energy expenditure and increased exogenous fat oxidation in young woman after ingestion of test meals with a low protein content. *Nutr. Metab.* **2008**, *5*, 25. [CrossRef] [PubMed]
27. Riggs, A.J.; White, B.D.; Gropper, S.S. Changes in energy expenditure associated with ingestion of high protein, high fat versus high protein, low fat meals among underweight, normal weight, and overweight females. *Nutr. J.* **2007**, *6*, 40. [CrossRef]
28. Casas-Agustench, P.; López-Uriarte, P.; Bulló, M.; Ros, E.; Gómez-Flores, A.; Salas-Salvadó, J. Acute effects of three high-fat meals with different fat saturations on energy expenditure, substrate oxidation and satiety. *Clin. Nutr.* **2009**, *28*, 39–45. [CrossRef]
29. Clevenger, H.C.; Kozimor, A.L.; Paton, C.M.; Cooper, J.A. Acute effect of dietary fatty acid composition on postprandial metabolism in women. *Exp. Physiol.* **2014**, *99*, 1182–1190. [CrossRef]
30. Xiong, Q.; Sun, L.; Luo, Y.; Yun, H.; Shen, X.; Yin, H.; Chen, X.; Lin, X. Different isocaloric meals and adiposity modify energy expenditure and clinical and metabolomic biomarkers during resting and exercise states in a randomized crossover acute trial of normal-weight and overweight/obese men. *J. Nutr.* **2022**, *152*, 1118–1129. [CrossRef]
31. Raben, A.; Agerholm-Larsen, L.; Flint, A.; Holst, J.J.; Astrup, A. Meals with similar energy densities but rich in protein, fat, carbohydrate, or alcohol have different effects on energy expenditure and substrate metabolism but not on appetite and energy intake. *Am. J. Clin. Nutr.* **2003**, *77*, 91–100. [CrossRef]
32. Bowden, V.L.; McMurray, R.G. Effects of training status on the metabolic responses to high carbohydrate and high fat meals. *Int. J. Sport Nutr. Exerc. Metab.* **2000**, *10*, 16–27. [CrossRef]
33. Dulloo, A.; Geissler, C.; Horton, T.; Collins, A.; Miller, D. Normal caffeine consumption: Influence on thermogenesis and daily energy expenditure in lean and postobese human volunteers. *Am. J. Clin. Nutr.* **1989**, *49*, 44–50. [CrossRef]
34. Barreto, G.; Grecco, B.; Merola, P.; Reis, C.E.G.; Gualano, B.; Saunders, B. Novel insights on caffeine supplementation, CYP1A2 genotype, physiological responses and exercise performance. *Eur. J. Appl. Physiol.* **2021**, *121*, 749–769. [CrossRef]
35. Hall, K.D.; Guo, J.; Courville, A.B.; Boring, J.; Brychta, R.; Chen, K.Y.; Darcey, V.; Forde, C.G.; Gharib, A.M.; Gallagher, I. Effect of a plant-based, low-fat diet versus an animal-based, ketogenic diet on ad libitum energy intake. *Nat. Med.* **2021**, *27*, 344–353. [CrossRef] [PubMed]
36. Conger, S.A.; Tuthill, L.M.; Millard-Stafford, M.L. Does Caffeine Increase Fat Metabolism? A Systematic Review and Meta-Analysis. *Int. J. Sport Nutr. Exerc. Metab.* **2023**, *33*, 112–120. [CrossRef] [PubMed]
37. Cheung, R.J.; Gupta, E.K.; Ito, M.K. Acute coffee ingestion does not affect LDL cholesterol level. *Ann. Pharmacother.* **2005**, *39*, 1209–1213. [CrossRef] [PubMed]
38. Benozzi, S.F.; Unger, G.; Campion, A.; Milano, P.G.; Pennacchiotti, G.L. Coffee intake one hour prior to phlebotomy produces no clinically significant changes in routine biochemical test results. *Biochem. Medica* **2023**, *33*, 165–172.
39. McKenzie, K.M.; Lee, C.M.; Mijatovic, J.; Haghighi, M.M.; Skilton, M.R. Medium-Chain triglyceride oil and blood lipids: A systematic review and meta-analysis of randomized trials. *J. Nutr.* **2021**, *151*, 2949–2956. [CrossRef] [PubMed]
40. Werner, L.B.; Hellgren, L.I.; Raff, M.; Jensen, S.K.; Petersen, R.A.; Drachmann, T.; Tholstrup, T. Effects of butter from mountain-pasture grazing cows on risk markers of the metabolic syndrome compared with conventional Danish butter: A randomized controlled study. *Lipids Health Dis.* **2013**, *12*, 99. [CrossRef] [PubMed]
41. Chen, M.; Li, Y.; Sun, Q.; Pan, A.; Manson, J.E.; Rexrode, K.M.; Willett, W.C.; Rimm, E.B.; Hu, F.B. Dairy fat and risk of cardiovascular disease in 3 cohorts of US adults. *Am. J. Clin. Nutr.* **2016**, *104*, 1209–1217. [CrossRef]
42. Engel, S.; Tholstrup, T. Butter increased total and LDL cholesterol compared with olive oil but resulted in higher HDL cholesterol compared with a habitual diet. *Am. J. Clin. Nutr.* **2015**, *102*, 309–315. [CrossRef] [PubMed]
43. Nehlig, A. Effects of coffee on the gastro-intestinal tract: A narrative review and literature update. *Nutrients* **2022**, *14*, 399. [CrossRef] [PubMed]
44. Little, T.J.; Horowitz, M.; Feinle-Bisset, C. Modulation by high-fat diets of gastrointestinal function and hormones associated with the regulation of energy intake: Implications for the pathophysiology of obesity. *Am. J. Clin. Nutr.* **2007**, *86*, 531–541. [CrossRef] [PubMed]
45. Friedenberg, F.K.; Parkman, H.P. Delayed gastric emptying: Whom to test, how to test, and what to do. *Curr. Treat. Options Gastroenterol.* **2006**, *9*, 295–304. [CrossRef] [PubMed]
46. Rohr, M.W.; Narasimhulu, C.A.; Rudeski-Rohr, T.A.; Parthasarathy, S. Negative effects of a high-fat diet on intestinal permeability: A review. *Adv. Nutr.* **2020**, *11*, 77–91. [CrossRef]
47. Ganda Mall, J.-P.; Östlund-Lagerström, L.; Lindqvist, C.M.; Algilani, S.; Rasoal, D.; Repsilber, D.; Brummer, R.J.; Keita, Å.V.; Schoultz, I. Are self-reported gastrointestinal symptoms among older adults associated with increased intestinal permeability and psychological distress? *BMC Geriatr.* **2018**, *18*, 75. [CrossRef]
48. Reid, W.; Brar, B. Ingestion of Brain Octane Oil. *Proc. UCLA Health* **2018**, *22*. Available online: https://www.proceedings.med.ucla.edu/wp-content/uploads/2018/11/Reid-A180924WR-BLM-edited.pdf (accessed on 6 July 2023).