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REVIEW ARTICLE

The Role of Ginger in Cognitive and Antidepressant Function: A Preliminary Exploration of the Effect of Added Sugars

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ABSTRACT

Ginger provides nutrition and bioactivity that can enhance cognitive function and act as an antidepressant. However, immoderate sugar consumption leads to cognitive decline and mental health issues. This study explores the role of added sugar in ginger's ability to improve cognition and act as an antidepressant. This study is a narrative review that used various sources to collect data. The literature was explored through online data-based and searching engines with preestablished keywords. Relevant articles were selected in two stages. The first stage was conducted by looking at appropriate articles based on the title, abstract, and keywords. The second stage was sorted according to the predetermined explicit criteria. The research design consists of a comprehensive analysis of the role of ginger and sugar and their combination in cognitive function and antidepressant effects. The finding shows that many sweet ginger products contain high sugar levels, which can reduce ginger's antioxidant activity and enhance oxidative stress. Additionally, sugar rotationally enhances Alzheimer's risk by raising inflammation and amyloid-beta levels. In conclusion, ginger offers great potential to enhance cognitive functions and has an antidepressant effect, but unfortunately, added sugar might negate the benefit.

KEYWORDS: *Antidepressant, Cognitive function, Ginger, Sugar*

Introduction

Cognitive function is a series of mental abilities that consist of information processing, memory, attention, and decision-making (Hsu et al., 2015). This function plays a crucial role in overall well-being, affecting an individual's ability to engage with the surroundings and complete daily tasks. Neurodegenerative diseases like Alzheimer's and Parkinson's are both influenced by oxidative stress and neuroinflammation, which leads to brain damage and neuronal loss (Arcusa et al., 2022). These diseases require specific pathological markers such as beta-amyloid plaques in Alzheimer's and α-synuclein accumulation in Parkinson's.

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Depression is the foremost severe mental disease, with a lifetime prevalence of 16.6%, characterized by core symptoms such as depressed mood, loss of interest, and suicidal behavior (Guo et al., 2014). Strong evidence links depression to cognitive impairment, which manifests as deficits in working memory, verbal learning, and processing speed. Additionally, depression is associated with various biological mechanisms, including oxidative stress, which occurs when there is an imbalance between oxidants (such as reactive oxygen species, or ROS) and antioxidants (Dania et al., 2024). This imbalance leads to inflammation, neurodegeneration, and cell damage, further affecting neurotransmitter signalling (particularly serotonin), neurogenesis, and synaptic plasticity.

Ginger (*Zingiber officinale*) is a rhizome often utilized as a spice, supplement, and flavoring agent. It is also utilized in traditional medicine due to its nutrition and bioactivity. Ginger contains two types of compounds, namely volatile and non-volatile compounds. Essential oils are the main volatile components in ginger. Ginger essential oil consists of sesquiterpenes (farnesene (10%), curcumin (18%), and zingiberene (36%)) and monoterpenes (sinole (1.3%), borneol (2.2%), linalool (1.3%), neral (citral b, 0.8%) and geranial (citral a, 1.4%)). Non-volatile components in ginger consist of gingerol, shogaol, paradol, and zingerone (Kiyama, 2020). Multiple studies have shown that ginger's antioxidant and anti-inflammatory compounds play a crucial role in preventing neurodegenerative diseases and antidepressant effects. Arcusa et al. (2022), found that ginger's antioxidant and anti-inflammatory promote the reduction of inflammation levels and oxidative stress in neurodegenerative diseases.

Sugar is one of the carbohydrates that people worldwide commonly consume. Sugar is one of the body's primary energy sources, crucial for brain function and physical activity. It is commonly added to food and beverages as a sweetener to improve taste and make them more appealing. Consuming sugar in this form has become necessary in many people's daily diets (AlAmmar et al., 2020). However, immoderate sugar consumption can cause diseases such as diabetes, obesity, and mental disorders that also inhibit cognitive function. High sugar consumption can impair memory and is associated with decreased neurogenesis, increased inflammatory responses and emotional order, such as anxiety and depression (Beilharz et al., 2015; Jacques et al., 2019; Mantantzis et al., 2019)

More than 100 studies have claimed that ginger has played a part in enhancing cognitive function and anti-depressant effects. Ginger content such as [6]-gingerol, zingerone, and shogaol have neuroprotective effects that will enhance cognitive impairment in Alzheimer's and Parkinson's and reduce inflammation (Kiyama, 2020). In addition, ginger contains antidepressant and antioxidant compounds such as flavonoids, phenols, and antioxidants that help reduce oxidative stress associated with depression (Dania et al., 2024). Only a few studies have focused on the sweet ginger products. Considering that ginger is often consumed with sugar, it is interesting to investigate whether the addition of sugar affects ginger's ability to improve cognitive function and antidepressants.

Materials and Method

This study is a literature review using a narrative review format. A narrative review is a qualitative approach to synthesizing existing research findings without a systematic methodology, focusing on building or evaluating an overarching theory and connecting studies on different topics to develop new theories (Siddaway et al., 2019). This literature review was conducted based on the following steps: (a) A protocol planning and developing; (b) conducting comprehensive literature research; (c) compiling data by sorting titles, abstracts, and keywords; (d) developing explicit selection criteria; (e) analyzing the data; (f) synthesizing information; and (g) reporting the results (Albeha et al., 2020; Singh & Kumar, 2020). The primary steps of this literature review include protocol planning, a comprehensive literature search, and literature screening based on the title, abstract, and keywords. The appropriate literature was selected using criteria. In addition, websites and journals were searched to know the composition of ginger and sugar in sweet ginger products that are circulating in the market. Methodological analysis and findings are conducted by synthesizing information from various studies to produce a conclusion. Finally, the review results are reported in a report that includes all steps and findings that have been obtained.

Data Base and Research Strategy

Data were collected from online databases such as Elsevier, MDPI, and Springer, as well as Google Scholar, explicitly targeting literature from 2014 to 2024 that focuses on the role of ginger and its bioactive components in cognitive function and antidepressant effects. This includes studies on the impact of the combination of ginger and sugar on these outcomes. Keywords used for the literature search were as follows: "ginger", "ginger consumption and cognitive function", "ginger consumption and cognitive function", "ginger consumption and antidepressant", "sugar", "sugar consumption and cognitive function", "Sugar consumption and antidepressant", "cognitive function", and "antidepressant".

Eligibility

Article selection was done in two steps. In the initial step, articles were screened based on the title, keyword, and abstract. Next, the articles carefully reviewed the screened articles, independently analyzing and extracting data to minimize bias, and then compiled their findings. Detailed notes regarding age, data collection tools, types of interventions, and significant outcomes were recorded. Irrelevant studies and insufficient quantitative data were excluded from the study. **Table 1.** summarises the inclusion and exclusion criteria considered based on various parameters.

Table 1. Eligibility criteria for scientific articles
(Siddaway et al., 2019; Holland et al., 2021; Sultana et al., 2022).

Criteria	Inclusions	Exclusions	Justification
Subject	All	No exclusions	To get more comprehensive results
Language	Indonesian and English	Another language	Possible errors in understanding data in another language can compromise its accuracy.
Access	Fully accessible	Not fully accessible	To confirm the explanation of an article more precisely
Metodologi	All	No exclusions	All methods are included to ensure a comprehensive analysis.
Article type	Research, reviews, surveys, books and websites	Dissertation	To gain a deeper understanding of the topic
Journal Rank	Indexed by Scopus (Q1-Q4) or Sinta (S1-S3)	Journals outside Scopus (Q1-Q4) or Sinta (S1-S3) accreditation	To ensure that the sources used come from trusted scientific publications and that their relevance and quality are recognized nationally and internationally.
Antioxidant analysis	Antioxidant analysis using the DPPH method	Antioxidant analysis using other the DPPH method	To obtain more accurate data for comparison

Seven inclusion and exclusion criteria—subject, language, access, methodology, article type, journal rank, and antioxidant analysis—aim to yield more relevant and accurate results.

Research Design

This section outlines the research design, detailing the methods used for reviewing the effects of ginger and added sugar on cognitive function and antidepressant properties. The technical design of this research, covering the steps involved in article inclusion, is illustrated in **Figure 1**.

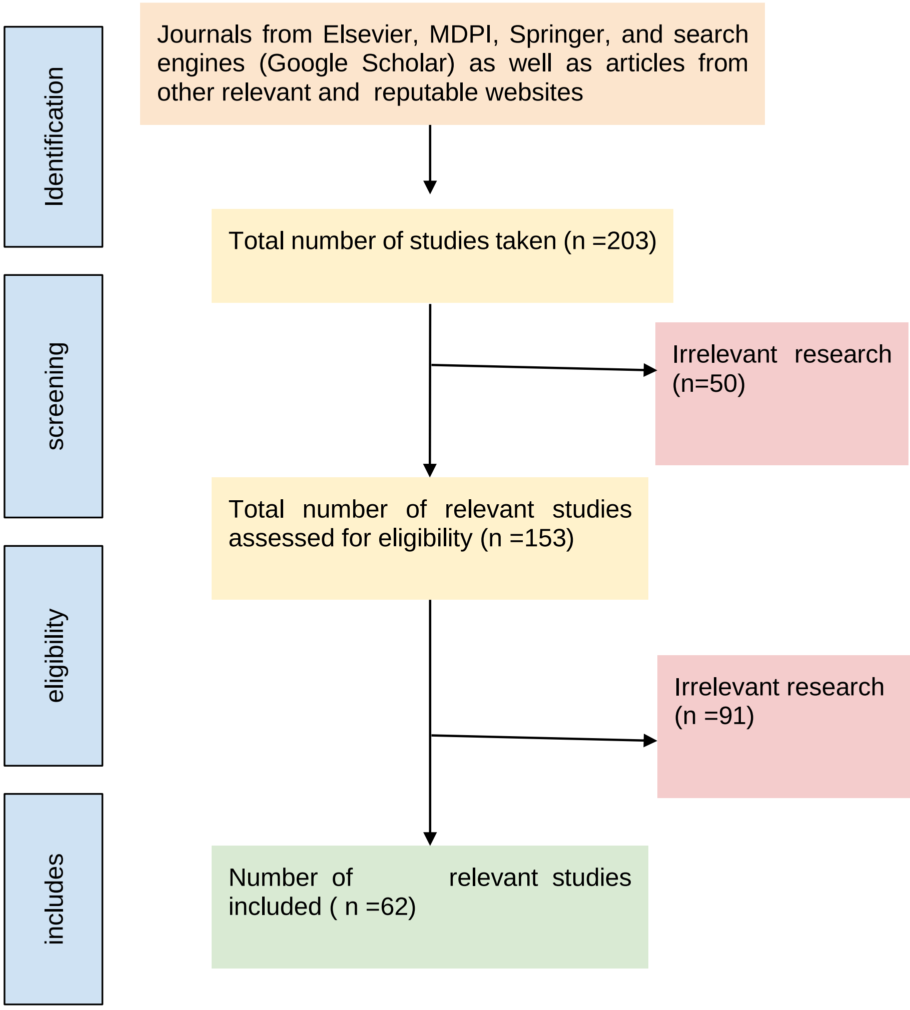

Figure 1. Research design

In the first stage of the research, journals from Elsevier, MDPI, and Springer, as well as articles from Google Scholar and other websites, are collected. In the initial screening phase, titles, abstracts, and keywords were reviewed. From the 203 articles collected, 153 met the initial criteria, while 50 were excluded. The process then continued to a second round of screening, where the remaining articles were assessed based on specific eligibility criteria outlined in **Table 1.** Ultimately, this process led to 62 articles for inclusion, while 91 articles were deemed unsuitable.

Based on the preliminary assessment of the literature, the conceptual design of this research centered on the potential effect of added sugar on cognitive function and the anti-depressant properties of ginger, as illustrated in **Figure 2.**

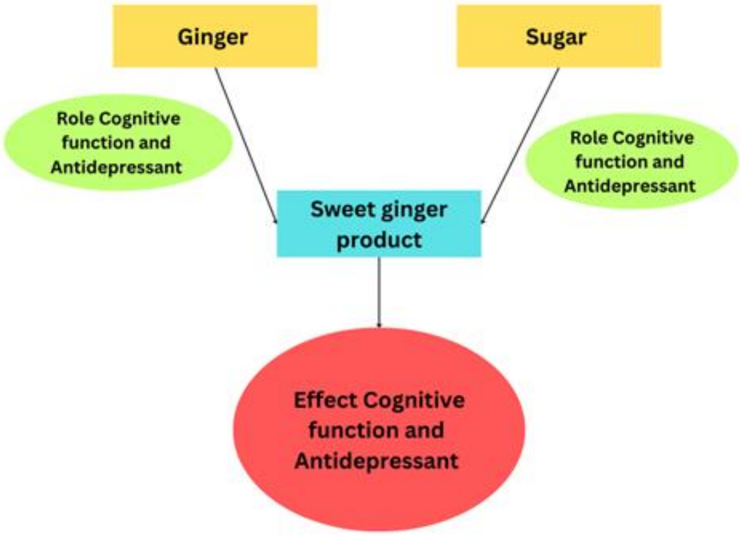

Figure 2. Research conceptual design

Based on the preliminary assessment of the literature, the conceptual design of this research centered on the potential effect of added sugar on cognitive function and the anti-depressant properties of ginger, as illustrated in **Figure 2.**

Results and Discussion

Ginger's Potential for Cognitive and Antidepressant Function

Ginger (*Zingiber officinale*) is a type of rhizome commonly used for its health benefits due to its various pharmacological properties. It is also known for its antioxidant and anti-inflammatory effects. Ginger contains antioxidant compounds such as shogaol, gingerol, zingerone, and paradol. (Shaukat et al., 2023; Ayustaningwarno et al., 2024). The antioxidant activity of ginger works by donating electrons or hydrogen atoms to free radicals. According to Sanjay & Shukla (2021), antioxidants operate through several mechanisms: 1) Protect cellular structures and prevent the formation of reactive oxygen species (ROS) in crucial areas, such as UV filters and cell membranes; 2) Absorb energy and electrons to halt ROS activity; 3) Inhibit or redirect ROS through antioxidant enzymes; 4) Bind to and deactivate metal ions to prevent the generation of ROS; and 5) Disrupt reaction chains by capturing radicals and breaking down ROS.

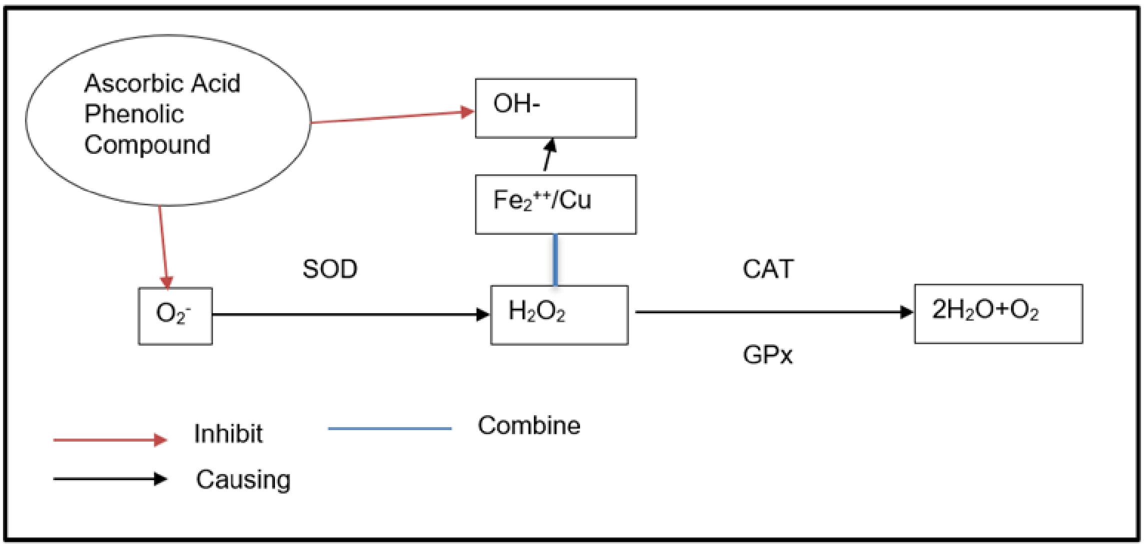

Figure 3. Mechanism of endogenous and exogenous antioxidant (Ayustaningwarno et al., 2024)

Figure 3 illustrates the mechanism of endogenous and exogenous antioxidants. The antioxidant mechanism involves enzymatic and non-enzymatic pathways to neutralize reactive oxygen species (ROS) (Ayustaningwarno et al., 2024). Superoxide Dismutase (SOD) converts superoxide radicals (O_2^-) into hydrogen peroxide (H_2O_2), which is further decomposed by Catalase (CAT) and Glutathione Peroxidase (GPx) into harmless water (H_2O) and oxygen (O_2). In the presence of transition metals like Fe^{2+} or Cu, H_2O_2 can generate reactive hydroxyl radicals (OH^-), contributing to oxidative stress and cellular damage. Non-enzymatic antioxidants, such as ascorbic acid (vitamin C) and phenolic compounds, help mitigate this damage by scavenging free radicals and preventing lipid peroxidation. A deficiency in exogenous antioxidants can lead to an imbalance between free radicals and antioxidants, resulting in oxidative stress, which is associated with various diseases. Ginger's antioxidants support cognitive function and exhibit antidepressant effects. The antioxidant activity was assessed based on the samples' ability to reduce stable free radicals, specifically 2,2-diphenyl-1-picrylhydrazyl (DPPH), with results presented in **Table 2.**

Table 2. Antioxidant properties of ginger

Ginger Varieties	Bioactive Compounds		Preteatment			IC_{50} (µg/ml)	Reference
	Compound	Total Phenolic (mg GAE/g extract)	Process	Temperature (°C)	Time (days)		
Red ginger (*Zingiber officinale var. rubrum*)		7.58	Shade drying	15	14	34.8 ± 1.27	
	Gingerol		Vacuum oven drying	45	3	27.2 ± 1.19	(Ayustaningwarno et al., 2024; Ghasemzadeh et al., 2016)

	Shogaol		Freeze drying	-60	3	29.1 ± 1.44	
	Paradol		Fresh	-	-	42.5 ± 1.62	
	Zingerone						
Elephant ginger (*Zingiber officinale Roscoe var officinale*)		8.03 ± 0.06	Sun-dried	28-44	3	15.23	
	Gingerol		Oven-drying	60	3	22.10	(Ayustaningwarno et al., 2024; Mustafa & Chin, 2023; Tung et al., 2017)
	Shogaol		Freeze drying	-30	-	22.25	
	Paradol		Vacuum drying	60	3	24.89	
	Zingerone		Fresh	-	-	20.18 ±0.12	

According to **Table 2**, the lowest IC_{50} value is found in the elephant ginger variety with sun-dried drying treatment (15.23 µg/ml), while the highest is found in the fresh red ginger (42.5 ± 1.62 µg/ml). The higher the IC_{50} value, the lower the antioxidant activity. Additionally, according to Wiendarlina & Sukaesih (2019), an IC_{50} value > 50 indicates very high antioxidant activity. Additionally, the phenolic content in elephant ginger is higher than in red ginger, with phenolics being one of the key antioxidant components.

The phenolic compounds in ginger stems act as antioxidant activity, which works by neutralizing free radicals by donating electrons or hydrogen atoms. (Zhang et al., 2022). This indicates that elephant ginger processes higher antioxidant activity. Aligns with the research Badrunanto et al. (2024), which points out that elephant ginger has the highest antioxidant activity compared to red ginger and emprit ginger. Additionally, the ginger pretreatment process also impacts ginger's antioxidant activity. The heat treatment boosted Ginger’s antioxidant activity as a result of the increased superoxide radical scavenging capacity (Sueishi et al., 2019).

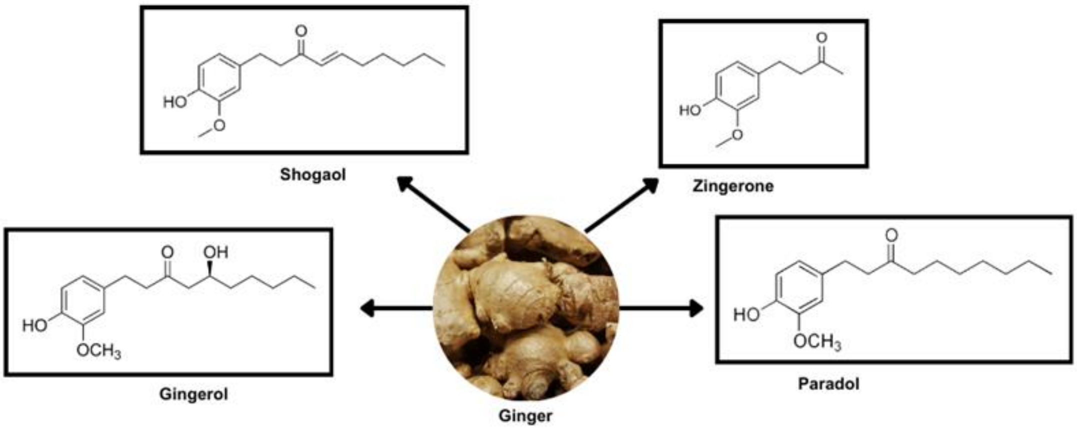

Figure 4. Chemical structures of antioxidant compounds present in ginger

Moreover, ginger's antioxidant properties also have significant anti-inflammatory effects. This section reviews preclinical studies examining the impact of ginger on cognitive function and its antidepressant-like effects, highlighting its promising role in health interventions. The results are presented in **Table 3**.

Table 3. Preclinical studies of ginger on cognitive and antidepressant functions

Compound Used	Concentration /Dosage	Subject	Behavior	Findings	Reference
Ginger	50 mg/ml	C57BL/6J mice,	-	Akt↓, NF-kB↓, TNF-α↓	(Ueno et al., 2014))
6-shogaol	100 µmol/L	HT-29/B6 and Caco-2	-	↓inflammation (TNF-α↓)	(Luettig et al., 2016)
Ginger extract	25, 50, 100 and 200 mg/ kg body weight	Male Sprague-Dawley	-	PGE2, TNF-α, dan IL-6↓	(Ezzat et al., 2018)
Ginger	250 mg/kg body weight	ICR male mice	faster navigation in the Morris water maze and increased latency in entering the dark compartment during the passive avoidance test	AChE activity, cytotoxic Effect, Lps-induced NO production, Suppressed TNF-a, IL-6, IL-1B.	(Kim et al., 2019)
6-gingerol	10 and 20 mg/kg body weight	Adult male Sprague-Dawley rats	shorter escape latencies to find the hidden platform and devote more time in the target quadrant at	IL-6, TNF-α, NO, NOS2 protein expresión in C6 cells.	(Zhang et al., 2018)

			the probe test, indicating improvements in learning and memory.		
Gingerol	10 mg/kg body weight /day,	Adult male Swiss Albino mice	-	α-secretase↑, Aβ-42↓, β-secretase↓, APH1a↓	(Halawany et al., 2023)
Ginger extract	108 mg/kg and 216 mg/kg body weight per day.	Adult male rat	reduced latency in locating the hidden platform during the Morris water maze test, indicating enhanced memory and retention.	Ache ↓	(Mahdy & Farrag, 2016)
Ginger extract	500 mg/kg body weight	Male Albino-Wistar rat	increase the spent time in the open arm, indicating decreased anxiety	↑serotonin	(Bano et al., 2021)

Abbreviations: APH1A,pharynxdefective1homolog; AAβ,amyloidβ; AChE,acetylcholinesterase; COX2,cyclooygenase-2; IL,interleukin; LPS,lipopolysaccharide; NF-κB,nuclearfactorκB; NO,nitrogen oksida;NO2,nitrogendioksida; p-Akt,phosphorylatedproteinkinaseB; TNF,tumornecrosisfactor; PGE2,ProstaglandinE2

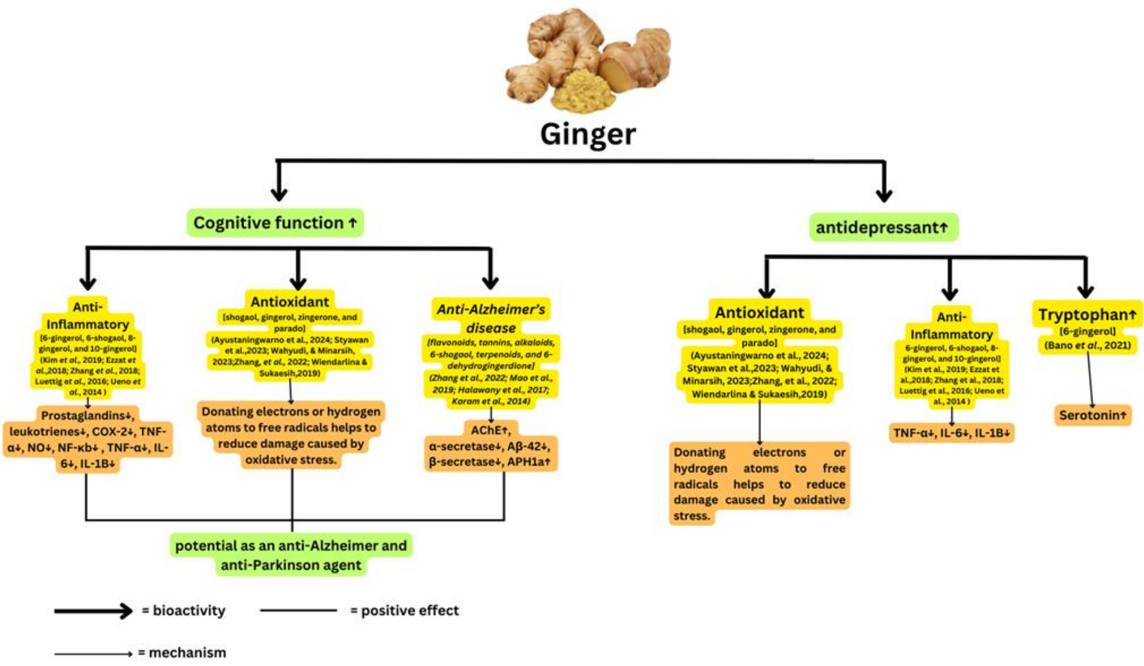

Figure 5. Ginger potential for cognitive and antidepressant function (↓ =decrease/inhibit, ↑ =increase)

Abbreviations: APH1A,pharynxdefective1homolog; AAβ,amyloidβ; AChE,acetylcholinesterase; COX2,cyclooygenase-2; IL,interleukin; LPS,lipopolysaccharide; NF-κB,nuclearfactorκB; NO,nitrogen oksida;NO2,nitrogendioksida; p-Akt,phosphorylatedproteinkinaseB; TNF,tumornecrosisfactor; PGE2,ProstaglandinE2

Alzheimer's disease (AD) is a neurodegenerative condition that is indicated by cognitive decline and memory impairment. Based on **Figure 5**, ginger has shown positive effects on cognitive function, particularly for Alzheimer's disease. Ginger exhibits both anti-inflammatory and anti-Alzheimer's properties. **Table 3** highlights ginger's role as an anti-Alzheimer's agent by enhancing α-secretase activity, reducing Aβ42 levels in the brain, and inhibiting γ-secretase and APH1a activity, which helps mitigate COX-2-related neuroinflammation. Research by Azam et al. (2014), further supports ginger's potential as an anti-Alzheimer agent by inhibiting acetylcholinesterase (AChE). This critical enzyme breaks down acetylcholine and regulates cerebral blood flow, β-amyloid aggregation, and inflammatory processes. Active components in ginger contribute to its anti-Alzheimer are flavonoids, tannins, alkaloids, 6-shogaol, terpenoids, and 6-dehydrogingerdione (Mao et al., 2019; Zhang et al., 2022).

Parkinson's disease (PD) is the second most prevalent neurological disorder among the elderly, following Alzheimer's disease. In PD patients, there is a significant increase in oxidative stress levels and inflammatory markers. Low antioxidant levels contribute to an inability to manage the production of free radicals and reactive oxygen and nitrogen species (ROS/RNS), leading to inflammation and neurodegeneration. As shown in **Figure 5**, ginger possesses potent antioxidant and anti-inflammatory properties, positively affecting Parkinson's disease. Ginger has a high antioxidant content that can help mitigate damage from oxidative stress. Additionally, as indicated in Table 2, ginger possesses anti-inflammatory properties by inhibiting inflammatory pathway components such as TNF-α, nitric oxide (NO), COX-2, and inducible nitric oxide synthase. This aligns with findings from Mao et al. (2019) and Zhang et al. (2022).

Depression is closely linked to cognitive impairments, including deficits in working memory, verbal learning, and processing speed. It is associated with various biological mechanisms, including oxidative stress—an imbalance between oxidants, such as antioxidant and reactive oxygen species (ROS) (Dania et al., 2024). As shown in **Figure 5**, ginger is an antidepressant due to its high antioxidant activity and ability to enhance serotonin synthesis. Ginger exhibits high antioxidant effects that play a crucial role in reducing oxidative stress. Antioxidants found in ginger can help support neurotransmitter balance and improve neurogenesis, potentially alleviating symptoms of depression. Additionally, ginger extract boosts serotonin production and has antidepressant effects. Active compounds in ginger, such as 6-gingerol, can increase the availability of tryptophan in the brain, a precursor to serotonin synthesis, which is vital for mood regulation and reducing depressive symptoms (Bano et al., 2021). The essential oil compounds in ginger play a significant role in creating its distinctive aroma. The scent of ginger can have a relaxing effect (Saras, 2023).

The pH test is conducted using a pH meter (Fasya et al., 2018). First, the pH meter is calibrated. The electrode of the pH meter is then immersed in the t*emulawak* extract sample. The detected pH value is observed until it stabilizes, and the final pH reading is recorded.

Sugar Effects on Cognitive and Antidepressant Function

Sugar is a common sweetener that consumed worldwide. It is a primary energy source for brain function and physical activity and is often utilized as a sweetener in various food and beverage products. This section examines the effect of sugar on cognitive function and its potential role in influencing antidepressant effects, with testing conducted through animal studies and the results presented in **Table 4.**

Table 4. The effect of sugar on cognitive function and antidepressants

Sucrose or Sweetener	Concentration (%)	Time (days)	Subject	Findings	Behavior	Reference
Sucrose	10	28	male Sprague Dawley rats	increased anxiety-like behaviors	increase the spent time in the close arm of the elevated plus maze (EPM), reflecting more significant anxiety and a reduced willingness to explore open areas	(Xu & Reichelt, 2018)
Sucrose solution	35	63	male Wistar rats	decreased memory performance and increased helpless behavior	reduced spatial memory performance in novel object recognition and object displacement tests, along with increased immobility in the forced swimming test, indicating heightened helpless behavior.	(Lemos et al., 2016)
High-carbohydrate diet : Condensed milk Sugar Chow	 45 10 45	56	male BALB/c mice	increased anxiety-like and depressive-like behaviour and aversive memory	reduced entries in the Elevated Plus Maze, increased immobility in the Tail Suspension Test	(Santos et al., 2018)
Sucrose	10	28	C57BL/6 mice	depression and anxiety-like behavior.	Increased immobility in the tail suspension test and decreased time spent in the open arms (elevated plus maze).	(S. Kim et al., 2018)
Sucrose and high fructose corn syrup for	11	30	adolescent male and adult male Sprague-Dawley rats	impairs hippocampal-dependent memory function and increases hippocampal markers of inflammation	Increased time to find escape routes, reduced percentage of correct hole investigations, and more significant disorientation in navigational tasks.	(Hsu et al., 2015)
Sucrose solution	10	21	Male Sprague -Dawley rats	deficits in the hippocampal-dependent place recognition task and increased hippocampal markers of oxidative	-	(Beilharz et al., 2015)

				stress (mRNA and NRF1) and inflammation (mRNA , IL-1, and TNF-a)		
Sucrose solution	20	84	The 3xTg-AD mice	increased amyloid-β dan tau phosphorylation	-	(Orr et al., 2014)

Table 4 shows that sugar consumption at concentrations of 10% or higher can have adverse effects on cognitive function and antidepressant properties. Sugar consumption can negatively impact cognitive function, leading to memory loss and an increased risk of Alzheimer's disease, as well as exacerbating symptoms of depression by heightening anxiety-like and depressive-like behaviors. The Dietary Guidelines for Americans advise restricting added sugars consumption to less than 10% of daily caloric intake to minimize potential health risk (Lee et al., 2023). The effects of cognitive decline and the antidepressant impact of sugar are illustrated more clearly in **Figure 6**.

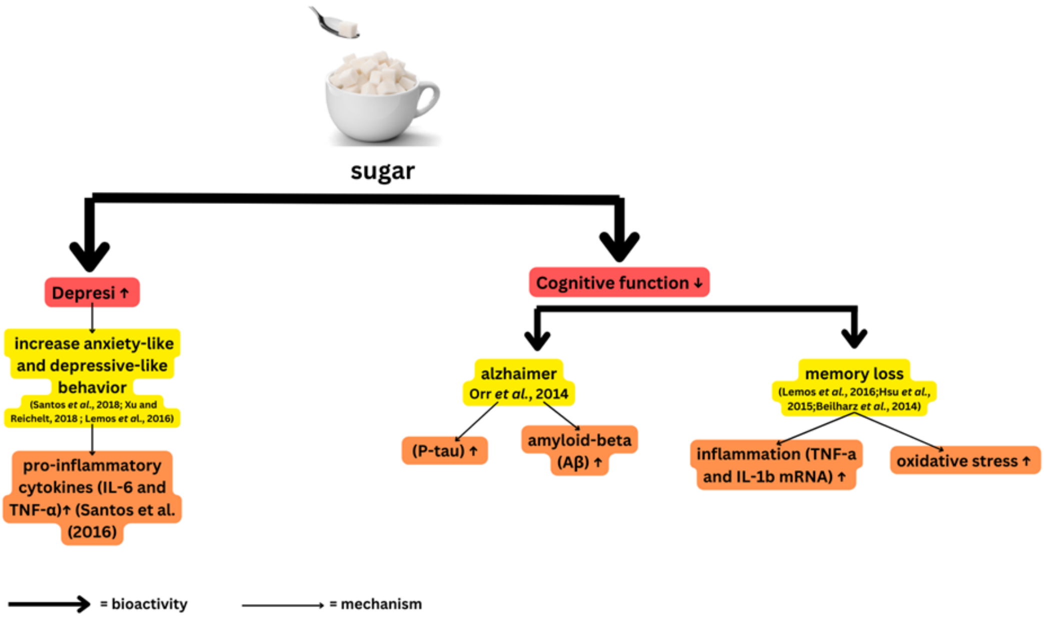

Figure 6. Sugar potential for cognitive and antidepressant function
(↓ =decrease/inhibit, ↑ =increase)

Abbreviations: AAβ,amyloidβ; IL,interleukin; TNF,tumornecrosisfactor

Based on **Figure 6**, it can be observed that sugar influences cognitive function and depression by increasing inflammation, oxidative stress, and elevating Alzheimer's markers. Excessive sugar intake can impair hippocampal function, crucial for memory and learning, due to increased inflammation (such as TNF-α and IL-1β) and oxidative stress (Beilharz et al., 2014; Hsu et al., 2015). In the context of Alzheimer's, high sugar consumption (20% sucrose solution) can lead to elevated Aβ levels, which release pro-inflammatory molecules, worsen brain damage, and trigger P-tau phosphorylation, accelerating neurodegeneration (Orr et al., 2014). high sucrose intake promotes the production of harmful Aβ and tau proteins through the upregulation of APP cleavage and

BACE-1 activity, contributing to the pathology observed in Alzheimer's disease. Furthermore, research by Santos et al. (2018), indicates that a high-carbohydrate diet can increase anxiety-like and depressive-like behaviours. This is associated with an increase in pro-inflammatory cytokines such as IL-1β, IL-6, and TNF-α. These cytokines can promote depressive symptoms through various pathways, which include the reduction of monoamine neurotransmitters such as serotonin and norepinephrine. (Febyan et al., 2020; Sutantio & Nugroho, 2020).

Potential Effects of Added Ginger and Sugar in Sweet Ginger Products Based on Cognitive and Antidepressant Function

Ginger is frequently consumed with added sugar, and various sweet ginger products, such as ginger candies and syrup. This section explores the content of ginger and sugar in sweet ginger products. The results are shown in **Table 5.**

Table 5. Composition of ginger and sugar in sweet ginger products

Product	Ginger content (%)	Sugar content (%)	Reference
Ginger Candy			
Hard candy	11,10	81,40	(Supriyanto et al., 2023)
Hard candy	1-2,5	80	(Akib et al., 2016)
Hard candy	12,80	77	(Rahman et al., 2023)
Hard candy	8-30	47-75	(The Ginger People, 2021)
Candy jelly	32	20	(Amalia et al., 2021)
Crystal candy	67	75	(The Ginger People, 2021)
Chewy candy	10	58	(The Ginger People, 2021)
Gummies	27	50	(The Ginger People, 2021)
Ginger Syrup			
	25	70	(Dwita et al., 2019)
	19,6	39,2	(Roslinda et al., 2022)
	20,8	62,5	(Andina Mayangsari et al., 2024)
Crystallized Ginger			
	34	45,40	(Tambunan et al., 2022)
	32,2	32,20	(Rachmad Saputra et al., 2022)
	50	50	(Rifkowaty & Martanto, 2016)
	44,80	22,40	(Badan POM, 2020).
	50%	50	(Ratnaningsih et al., 2021)
	32,50	56,90	(Kartika et al., 2023)

Table 5 showed the percentage of ginger and sugar in each type of sweet ginger product. Ginger candy contains 8-67% ginger and 47-81.4% sugar. Ginger syrup contains 20-25% ginger and 39.2-70% sugar. Crystallised Ginger contains 30.6-50% ginger and 32.2-69% sugar. Overall, sweet ginger products commonly contain a ginger of 8-67% and a sugar of 20-81.4%. This indicates that a significant amount of sugar is added to ginger products that are available to the public. High sugar consumption (≥10%) can damage memory and is associated with decreased neurogenesis, increased inflammatory responses, and emotional disorders such as anxiety and depression. (Beilharz et al., 2015; Jacques et al., 2019; Mantantzis et al., 2019). Inflammation can activate microglia, the brain's immune cells, leading to the release of pro-inflammatory cytokines like IL-1β, IL-6, and TNF-α. This activation may result in brain tissue damage and disrupted neuron communication, contributing to depressive symptoms by reducing key neurotransmitters like serotonin and norepinephrine. (Rosyanti et al., 2017; Febyan et al., 2020; Sutantio & Nugroho, 2020). However, the addition of sugar has been shown to reduce antioxidant activity, as seen in Table 6.

Table 6. Antioxidant properties of fresh and processed ginger (Koch et al., 2016)

Product	Description	IC50 (µg/ml)
Fresh ginger	*Zingiber officinale Roscoe*	210 ± 10
Hard candy with ginger	ginger-flavoured hard candies	730 ± 36
Ginger in sugar (sweet 1)	sliced ginger with sugar	320 ± 22
Ginger in sugar (sweet 2)	antioxidant analysis using the DPPH method	420 ± 26

From **Table 6.**, it can be observed that the highest IC_{50} value is found in the product Hard Candy with Ginger (730 ± 36µg/ml), while the lowest is in Fresh Ginger (210 ± 10 µg/ml). This indicates a decrease in antioxidant activity in ginger products with added sugar compared to fresh ginger, as evidenced by increased IC_{50} values. This reduction occurs because added sugar affects antioxidant activity by lowering methylation groups and hydrogen atoms, which decreases the availability of hydrogen atoms that act as donors to free radicals, ultimately degrading antioxidant compounds. (Diyana et al., 2024).

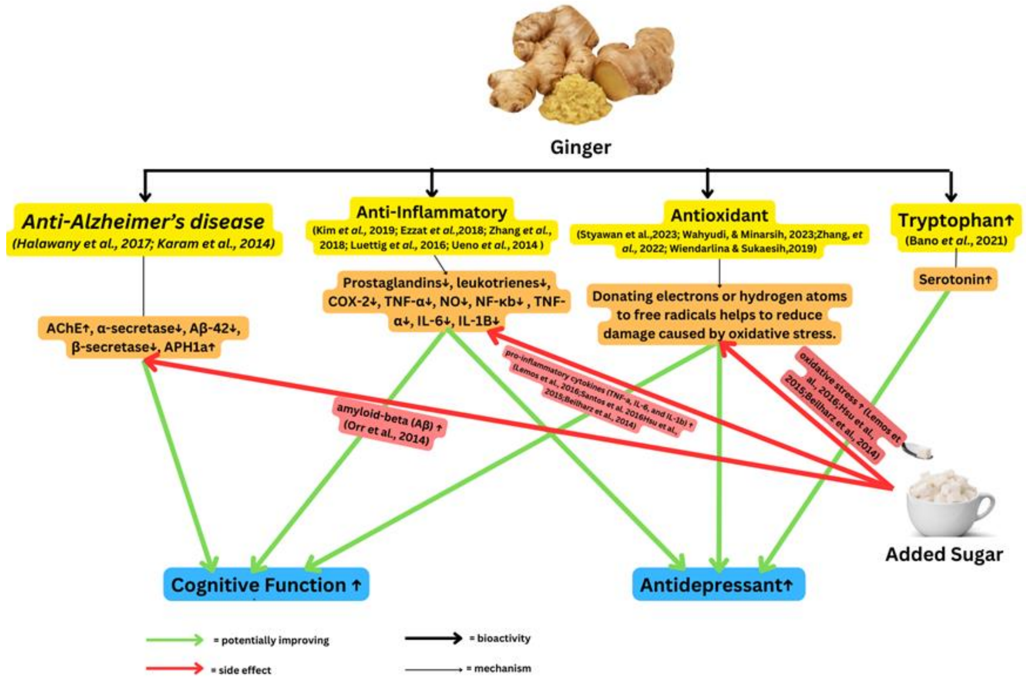

Figure 7. Proposed concept of the relationship between sugar addition and ginger's potential effects on cognitive and antidepressant function
(↓ =decrease/inhibit, ↑ =increase)

Abbreviations:APH1A,pharynxdefective1homolog; AAβ,amyloidβ; AChE,acetylcholinesterase; COX2,cyclooygenase-2; IL,interleukin; LPS,lipopolysaccharide; NF-κB,nuclearfactorκB; NO,nitrogen oksida;NO2,nitrogendioksida; p-Akt,phosphorylatedproteinkinaseB; TNF,tumornecrosisfactor; PGE2,ProstaglandinE2

Figure 7 showed that adding sugar may reduce ginger's potential for enhancing cognitive function and its antidepressant effects. Added sugar can lead to more inflammation, oxidative stress, and an increased risk of Alzheimer's disease. It may also interfere with ginger's ability to fight Alzheimer's by raising amyloid-beta (Aβ) levels. This increase in oxidative stress might occur because the antioxidant function is impaired. Furthermore, added sugar can inhibit ginger's anti-inflammatory effects, as indicated by the increasing levels of IL-6, TNF-α, and IL-1β. As stated by Prasad & Dhar (2014)Sugar can promote inflammation by creating advanced glycation and products (AGEs) that interact with the RAGE receptor, promoting NF-κB and raising the production of pro-inflammatory cytokines and reactive oxygen species (ROS).

Conclusion

Ginger has potential benefits in combating Alzheimer's disease, which can improve cognitive function and provide antidepressant effects. In contrast, sugar has negatively impact cognitive function and increase depression, inflammation, and oxidative stress. High sugar intake may contribute to memory issues, heightened anxiety, and depressive behaviors. Therefore, it is crucial to determine how sugar can undermine the beneficial effect of ginger on cognitive function and depression effect. Specifically, sugar can lower antioxidant activity, increase inflammation, and elevate amyloid-beta levels, potentially increasing the risk of Alzheimer's disease.

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Conflict of Interest

The authors have no conflicts of interest to declare. This work is a form of learning outcome only for university educational purposes. All co-authors have seen and agreed with the manuscript's contents, and there is no financial interest to report. We certify that the submission is an original work and is not under review at any other publication.

Author Contributions

Jennifer Mariza Lynn conducted the article selection and wrote the manuscript. Budi Widianarko and Mellia Harumi developed the research method and revised the manuscript. All authors agreed to the final version of this manuscript.

Ethical Statement

Ethics approval was not required for this study. This article does not carry any studies involving animals performed by any of the authors.

References

Akib, N. I., Baane, W., & Fristiohady, A. (2016). Formulation of Herbal Hard Candy Contains Red Ginger (Zingiber officinale var. rubrum) Extract. *Jf Fik Uinam*, *4*(1), 1–8.

AlAmmar, W. A., Albeesh, F. H., & Khattab, R. Y. (2020). Food and Mood: the Corresponsive Effect. *Current Nutrition Reports*, *9*(3), 296–308. https://doi.org/10.1007/s13668-020-00331-3

Albeha, M., Fernandes, S., Mesquita, D., Seabra, F., & Ferreira-Oliveira, A. (2020). La empleabilidad de los graduados y el desarrollo de competencias en la educación superior: una revisión sistemática de la literatura utilizando PRISMA. *Sustainability*, *12*(15), 1–27. https://www-scopus-com.unmsm.lookproxy.com/record/display.uri?eid=2-s2.0-85089738422&origin=resultslist&sort=plf-f&src=s&nlo=&nlr=&nls=&sid=45029e5b6145459ddd4bee918b9d0e30&sot=a&sdt=cl&cluster=scoexactsrctitle%2C%22Revesco+Revista+De+Estudios+Cooperativo

Amalia, S. R., Rostini, I., Syamsuddin, M. L., & Pratama, R. I. (2021). Chemical and Organoleptic Characteristics of Seaweed Jelly Candy (Eucheuma cottonii) with the Addition of Red Ginger (Zingiber officinale Roscoe) Extract. *Asian Journal of Fisheries and Aquatic Research*, *June*, 33–43. https://doi.org/10.9734/ajfar/2021/v12i530246

Andina Mayangsari, Angga Kurdiansyah, & Moch Imam Vickry Musthofa. (2024). Sosialisasi Dan Praktek Pemberdayaan Masyarakat Dalam Pembuatan Sirup Jahe Pada Dasawiswa Melati Sumberanyar Banyuputih Situbondo. *Jurnal Kabar Masyarakat*, *2*(2), 264–269. https://doi.org/10.54066/jkb.v2i2.1973

Arcusa, R., Villaño, D., Marhuenda, J., Cano, M., Cerdà, B., & Zafrilla, P. (2022). Potential Role of Ginger (Zingiber officinale Roscoe) in Preventing Neurodegenerative Diseases. *Frontiers in Nutrition*, *9*(March). https://doi.org/10.3389/fnut.2022.809621

Ayustaningwarno, F., Anjani, G., Ayu, A. M., & Fogliano, V. (2024). A critical review of Ginger's (Zingiber officinale) antioxidant, anti-inflammatory, and immunomodulatory activities. *Frontiers in Nutrition*, *11*(June), 1–16. https://doi.org/10.3389/fnut.2024.1364836

Azam, F., Amer, A. M., Abulifa, A. R., & Elzwawi, M. M. (2014). Ginger components as new leads for the design and development of novel multi-targeted anti-Alzheimer's drugs: A computational investigation. Drug design, development and therapy, 2045-2059.

Badan POM. (2020). Pedoman untuk UMKM dalam pengolahan jahe. https://istanaumkm.pom.go.id/download/1015

Badrunanto, Wahyuni, W. T., Farid, M., Batubara, I., & Yamauchi, K. (2024). Antioxidant components of the three different varieties of Indonesian ginger essential oil: In vitro and computational studies. *Food Chemistry Advances*, *4*(November 2023), 100558. https://doi.org/10.1016/j.focha.2023.100558

Bano, S., Sharif, H., & Badawy, A. A.-B. (2021). Effects of oral administration of an aqueous ginger extract on anxiety behavior and tryptophan and serotonin metabolism in the rat. *Asian Journal of Medical Sciences*, *12*(6), 38–43. https://doi.org/10.3126/ajms.v12i6.34480

Beilharz, J. E., Maniam, J., & Morris, M. J. (2015). Diet-induced cognitive deficits: The role of fat and sugar, potential mechanisms and nutritional interventions. *Nutrients*, *7*(8), 6719–6738. https://doi.org/10.3390/nu7085307

Dania, I. A., Rusdiana, Rambe, A. S., Harahap, U., Effendy, E., & Novziransyah, N. (2024). Active Compounds of Red Ginger as Antioxidant Activity in the Supplementation and Treatment of Depression. *Qubahan Academic Journal*, *4*(1), 177–184. https://doi.org/10.48161/qaj.v4n1a208

Diyana, I., Kamaluddin, K., Nawawi, N. M., Syamsu, R. F., Royani, I., & Haidir Bima, I. (2024). Comparison of Antioxidants in Red Ginger Powder Preparations with the Addition of Sucrose and Red Ginger Powder Preparations Without the Addition of Sucrose. *Jurnal.Poltekkespalu.Ac.Id*, *17*(4), 1436–1441. https://jurnal.poltekkespalu.ac.id/index.php/JIK/article/view/3554

Dwita, L. P., Maifitrianti, M., & Viviandhari, D. (2019). Pembuatan Sirup Jahe Merah dan Pemafaatannya dalam Kesehatan. *Jurnal SOLMA*, *8*(1), 111. https://doi.org/10.29405/solma.v8i1.3080

El Halawany, A. M., EL Sayed, N. S., Abdallah, H. M., & El Dine, R. S. (2023). Retraction Note: Protective effects of gingerol on streptozotocin-induced sporadic Alzheimer's disease: emphasis on inhibition of β-amyloid, COX-2, alpha-, beta - secretases and APH1a (Scientific Reports, (2017), 7, 1, (2902), 10.1038/s41598-017-02961-0). *Scientific Reports*, *13*(1), 41598. https://doi.org/10.1038/s41598-023-36652-w

Ezzat, S. M., Ezzat, M. I., Okba, M. M., Menze, E. T., & Abdel-Naim, A. B. (2018). The hidden mechanism beyond ginger (Zingiber officinale Rosc.) potent in vivo and in vitro anti-inflammatory activity. *Journal of Ethnopharmacology*, *214*, 113–123. https://doi.org/10.1016/j.jep.2017.12.019

Febyan, F., Wijaya, S. H., Tannika, A., & Hudyono, J. (2020). Peranan Sitokin pada Keadaan Stres sebagai Pencetus Depresi. *Jurnal Penyakit Dalam Indonesia*, *6*(4), 210. https://doi.org/10.7454/jpdi.v6i4.285

Ghasemzadeh, A., Jaafar, H. Z. E., & Rahmat, A. (2016). Variation of the phytochemical constituents and antioxidant activities of Zingiber officinale var. rubrum Theilade associated with different drying methods and polyphenol oxidase activity. *Molecules*, *21*(6). https://doi.org/10.3390/molecules21060780

Guo, M., Mi, J., Jiang, Q. M., Xu, J. M., Tang, Y. Y., Tian, G., & Wang, B. (2014). Metformin may produce antidepressant effects through improvement of cognitive function among depressed patients with diabetes mellitus. *Clinical and Experimental Pharmacology and Physiology*, *41*(9), 650–656. https://doi.org/10.1111/1440-1681.12265

Holland, I., Deville, N. V., Browning, M. H. E. M., Buehler, R. M., Hart, J. E., Aaron Hipp, J., Mitchell, R., Rakow, D. A., Schiff, J. E., White, M. P., Yin, J., & James, P. (2021). Measuring nature contact: A narrative review. *International Journal of Environmental Research and Public Health*, *18*(8), 1–15. https://doi.org/10.3390/ijerph18084092

Hsu, T. M., Konanur, V. R., Taing, L., Usui, R., Kayser, B. D., Goran, M. I., & Kanoski, S. E. (2015). Effects of sucrose and high fructose corn syrup consumption on spatial memory function and hippocampal neuroinflammation in adolescent rats. *Hippocampus*, *25*(2), 227–239. https://doi.org/10.1002/hipo.22368

Jacques, A., Chaaya, N., Beecher, K., Ali, S. A., Belmer, A., & Bartlett, S. (2019). The impact of sugar consumption on stress driven, emotional and addictive behaviors. *Neuroscience and Biobehavioral Reviews*, *103*(March), 178–199. https://doi.org/10.1016/j.neubiorev.2019.05.021

Kartika, W., Sulistyowati, E., Herlyanti, K., Mighfar Syukur, Nugraheni, B., & Suryaning Prahasiwi, M. (2023). Pembuatan Minuman Herbal Instan dengan Bahan Jahe, Sereh, Kelor (Jaseke) untuk Stamina Tubuh. *Jurnal DiMas*, *5*(2), 58–63. https://doi.org/10.53359/dimas.v5i2.68

Kim, J. E., Shrestha, A. C., Kim, H. S., Ham, H. N., Kim, J. H., Kim, Y. J., Noh, Y. J., Kim, S. J., Kim, D. K., Jo, H. K., Kim, D. S., Moon, K. H., Lee, J. H., Jeong, K. O., & Leem, J. Y. (2019). WS-5 Extract of Curcuma longa, Chaenomeles sinensis, and Zingiber officinale Contains Anti-AChE Compounds and Improves β -Amyloid-Induced Memory Impairment in Mice. *Evidence-Based Complementary and Alternative Medicine*, *2019*. https://doi.org/10.1155/2019/5160293

Kim, S., Shou, J., Abera, S., & Ziff, E. B. (2018). Sucrose withdrawal induces depression and anxiety-like behavior by Kir2.1 upregulation in the nucleus accumbens. *Neuropharmacology*, *130*, 10–17. https://doi.org/10.1016/j.neuropharm.2017.11.041

Kiyama, R. (2020). Nutritional implications of ginger: chemistry, biological activities and signaling pathways. *Journal of Nutritional Biochemistry*, *86*, 108486. https://doi.org/10.1016/j.jnutbio.2020.108486

Koch, W., Kukula-Koch, W., Dziedzic, M., Glowniak, K., & Asakawa, Y. (2016). Influence of thermal processing and in vitro digestion on the antioxidant potential of ginger and ginger containing products. *Natural Product Communications*, *11*(8), 1153–1156. https://doi.org/10.1177/1934578x1601100830

Lee, S. H., Zhao, L., Park, S., Moore, L. V., Hamner, H. C., Galuska, D. A., & Blanck, H. M. (2023). High Added Sugars Intake among US Adults: Characteristics, Eating Occasions, and Top Sources, 2015–2018. *Nutrients*, *15*(2), 2015–2018. https://doi.org/10.3390/nu15020265

Lemos, C., Rial, D., Gonçalves, F. Q., Pires, J., Silva, H. B., Matheus, F. C., da Silva, A. C., Marques, J. M., Rodrigues, R. J., Jarak, I., Prediger, R. D., Reis, F., Carvalho, R. A., Pereira, F. C., & Cunha, R. A. (2016). High sucrose consumption induces memory impairment in rats associated with electrophysiological modifications but not with metabolic changes in the hippocampus. *Neuroscience*, *315*, 196–205. https://doi.org/10.1016/j.neuroscience.2015.12.018

Luettig, J., Rosenthal, R., Lee, I. F. M., Krug, S. M., & Schulzke, J. D. (2016). The ginger component 6-shogaol prevents TNF-α-induced barrier loss via inhibition of PI3K/Akt and NF-κB signaling. *Molecular Nutrition and Food Research*, *60*(12), 2576–2586. https://doi.org/10.1002/mnfr.201600274

Mahdy, K. A., & Farrag, A. R. H. (2016). *Protective Effect of Ginger (Zingiber officinale) on Alzheimer's disease Induced in Rats. February.*

https://www.researchgate.net/profile/Abdel-RazikFarrag/publication/283910018_Protective_Effect_of_Ginger_Zingiber_officinale_on_Alzheimer's_disease_Induced_in_Rats/links/56bc5d4908ae0a407db15c71/Protective-Effect-of-Ginger-Zingiber-officinale-on-Alzheimers-disease-Induced-in-Rats.pdf

Mantantzis, K., Schlaghecken, F., Sünram-Lea, S. I., & Maylor, E. A. (2019). Sugar rush or sugar crash? A meta-analysis of carbohydrate effects on mood. *Neuroscience and Biobehavioral Reviews*, *101*(March), 45–67. https://doi.org/10.1016/j.neubiorev.2019.03.016

Mao, Q. Q., Xu, X. Y., Cao, S. Y., Gan, R. Y., Corke, H., Beta, T., & Li, H. Bin. (2019). Bioactive compounds and bioactivities of ginger (zingiber officinale roscoe). *Foods*, *8*(6), 1–21. https://doi.org/10.3390/foods8060185

Mustafa, I., & Chin, N. L. (2023). Antioxidant Properties of Dried Ginger (Zingiber officinale Roscoe) var. Bentong. *Foods*, *12*(1), 1–18. https://doi.org/10.3390/foods12010178

Orr, M. E., Salinas, A., Buffenstein, R., & Oddo, S. (2014). Mammalian target of rapamycin hyperactivity mediates the detrimental effects of a high sucrose diet on Alzheimer's disease pathology. *Neurobiology of Aging*, *35*(6), 1233–1242. https://doi.org/10.1016/j.neurobiolaging.2013.12.006

Prasad, K., & Dhar, I. (2014). Oxidative stress as a mechanism of added sugar-induced cardiovascular disease. *International Journal of Angiology*, *23*(4), 217–226. https://doi.org/10.1055/s-0034-1387169

Rachmad Saputra, Bela Safitri Wahyudi, Fajar Aulia Rahman, Muhammad Ammar Huseini, Harry Firmansyah, Arum Sekar Priyati, Hanifa Febriani, Nurul Fadhila Ramadhona, Putri Khairani, Rifa Shovia, & Riska JH Jundiah. (2022). PENGOLAHAN RIMPANG JAHE (Zingiber officinale Rosc.) SEBAGAI MINUMAN HERBAL PADA ERA NEW NORMAL DI DESA GUNUNG MULYA KABUPATEN KAMPAR. *PAKDEMAS : Jurnal Pengabdian Kepada Masyarakat*, *2*(1), 147–152. https://doi.org/10.58222/pakdemas.v2i1.78

Rahman, I. R., Hairunnisa, H., Kurnianto, E., Kartikasari, D., & Hamdi, A. (2023). Formulasi Hard Candy Dengan Kombinasi Jahe Merah, Lemon Dan Sereh. *Jurnal Ilmiah Pharmacy*, *10*(2), 107–116. https://doi.org/10.52161/jiphar.v10i2.500

Ratnaningsih, A. T., Insusanty, E., & Ervayendri. (2021). Pelatihan Pembuatan Minuman Kesehatan Jahe Merah Instan BagiTim Penggerak Pemberdayaan Dan Kesejahteraan KeluargaKelurahan Limbungan Kota Pekanbaru. *Prosiding Seminar Nasional Pengabdian Kepada Masyarakat*, *1*(2), 33–38. https://journal.unilak.ac.id/index.php/SNPKM/article/view/11406

Rifkowaty, E. E., & Martanto. (2016). MINUMAN FUNGSIONAL SERBUK INSTAN JAHE (Zingiber officinalerosc) DENGAN VARIASI PENAMBAHAN EKSTRAK BAWANG MEKAH(Eleutherine Americana Merr) SEBAGAI PEWARNA ALAMI. *Jurnal Teknik Pertanian Lampung*, *4*(4), 315–324.https://r.search.yahoo.com/_ylt=Awr1UZkvbKNnegIAWO7LQwx.;_ylu=Y29sbwNzZzMEcG9zAzEEdnRpZAMEc2VjA3Ny/RV=2/RE=1739972911/RO=10/RU=https%3a%2f%2fmedia.neliti.com%2fmedia%2fpublications%2f134382-ID-none.pdf/RK=2/RS=qsCltIzcN8L1J4p0gDKBzngd9Ak-

Roslinda, E., Widiastuti, T., Khumsyah, A. A. N., Nurfatimah, U., Karlindasari, W., & Syasabila, D. A. (2022). Pelatihan Pembuatan Sirup Jahe Dalam Usaha Menciptakan Nilai Tambah Tanaman Jahe Masyarakat. *JMM (Jurnal Masyarakat Mandiri)*, *6*(4), 2674. https://doi.org/10.31764/jmm.v6i4.8977

Rosyanti, L., Usman, R. D., Hadi, I., & Syahrianti, S. (2017). Kajian Teoritis Hubungan antara Depresi dengan Sistem Neuroimun. *Health Information : Jurnal Penelitian*, *9*(2), 78–97. https://doi.org/10.36990/hijp.v9i2.104

Sanjay, S. S., & Shukla, A. K. (2021). Potential Therapeutic Applications of Nano-antioxidants. In *Potential Therapeutic Applications of Nano-antioxidants*. https://doi.org/10.1007/978-981-16-1143-8

Santos, C. J., Ferreira, A. V. M., Oliveira, A. L., Oliveira, M. C., Gomes, J. S., & Aguiar, D. C. (2018). Carbohydrate-enriched diet predispose to anxiety and depression-like behavior after stress in mice. *Nutritional Neuroscience*, *21*(1), 33–39. https://doi.org/10.1080/1028415X.2016.1213529

Saras, T. (2023). The Wonders of Ginger: Unveiling the Health Benefits and Culinary Magic. Tiram Media.https://books.google.co.id/books?hl=en&lr=&id=MtPQEAAAQBAJ&oi=fnd&pg=PA1&dq=Saras,+T.+(2023).+The+Wonders+of+Ginger:+Unveiling+the+Health+Benefits+and+Culinary+Magic.+Tiram+Media.&ots=wT473yenRj&sig=At6aJJ1leFwzm2obHtI6lG6ADn8&redir_esc=y#v=onepage&q=Saras%2C%20T.%20(2023).%20The%20Wonders%20of%20Ginger%3A%20Unveiling%20the%20Health%20Benefits%20and%20Culinary%20Magic.%20Tiram%20Media.&f=false

Shaukat, M. N., Nazir, A., & Fallico, B. (2023). Ginger Bioactives: A Comprehensive Review of Health Benefits and Potential Food Applications. *Antioxidants*, *12*(11), 1–26. https://doi.org/10.3390/antiox12112015

Siddaway, A. P., Wood, A. M., & Hedges, L. V. (2019). How to Do a Systematic Review: A Best Practice Guide for Conducting and Reporting Narrative Reviews, Meta-Analyses, and Meta-Syntheses. *Annual Review of Psychology*, *70*, 747–770. https://doi.org/10.1146/annurev-psych-010418-102803

Singh, S., & Kumar, K. (2020). Review of literature of lean construction and lean tools using systematic literature review technique (2008–2018). *Ain Shams Engineering Journal*, *11*(2), 465–471. https://doi.org/10.1016/j.asej.2019.08.012

Sueishi, Y., Masamoto, H., & Kotake, Y. (2019). Heat treatments of ginger root modify but not diminish its antioxidant activity as measured with multiple free radical scavenging (MULTIS) method. *Journal of Clinical Biochemistry and Nutrition*, *64*(2), 143–147. https://doi.org/10.3164/jcbn.18-41

Sultana, A., Rahman, K., Heyat, M. B. Bin, Sumbul, Akhtar, F., & Muaad, A. Y. (2022). Role of Inflammation, Oxidative Stress, and Mitochondrial Changes in Premenstrual Psychosomatic Behavioral Symptoms with Anti-Inflammatory, Antioxidant Herbs, and Nutritional Supplements. *Oxidative Medicine and Cellular Longevity*, *2022*. https://doi.org/10.1155/2022/3599246

Supriyanto, S., Mojiono, M., & Dewi, M. W. P. (2023). Efek Penambahan Ekstrak Jahe (Zingiber officinale Rosc.) Serta Rasio Glukosa dan Fruktosa Pada Sucrose-Free Hard Candy. *Rekayasa*, *16*(2), 122–131. https://doi.org/10.21107/rekayasa.v16i2.20158

Sutantio, E. H., & Nugroho, I. I. (2020). Inflamation As a Depression-Causing Factor in Chronic Kidney Disease Patients. *Journal of Psychiatry Psychology and Behavioral Research*, *1*(1), 15–19. https://jppbr.ub.ac.id/index.php/jppbr/article/view/4

Tambunan, I. J., Ginting, E., Yulia, R., & Ramadhan, A. (2022). Sosialisasi Pembuatan Minuman Wedang Jahe Instan Untuk Penguat Imunitas Mencegah Covid-19 Di Sekolah Menengah Kejuruan (Smk) Farmasi Apipsu Medan. *Jurnal Pengabdian Masyarakat Tjut Nyak Dhien*, *1*(2), 76–82. https://doi.org/10.36490/jpmtnd.v1i2.312

The Ginger People. (2021). GIN GINS® Ginger Candy. The Ginger People. https://gingerpeople.com/products/gin-gins-super-strength-ginger-candy/

Tizabi, Y., Hurley, L. L., Qualls, Z., & Akinfiresoye, L. (2014). Relevance of the anti-inflammatory properties of curcumin in neurodegenerative diseases and depression. *Molecules*, *19*(12), 20864–20879. https://doi.org/10.3390/molecules191220864

Tung, B. T., Thu, D. K., Thu, N. T. K., & Hai, N. T. (2017). Antioxidant and acetylcholinesterase inhibitory activities of ginger root (Zingiber officinale Roscoe) extract. *Journal of Complementary and Integrative Medicine*, *14*(4). https://doi.org/10.1515/jcim-2016-0116

Ueno, N., Hasebe, T., Kaneko, A., Yamamoto, M., Fujiya, M., Kohgo, Y., Kono, T., Wang, C. Z., Yuan, C. S., Bissonnette, M., Chang, E. B., & Musch, M. W. (2014). TU-100 (Daikenchuto) and ginger ameliorate anti-CD3 antibody induced T cell-mediated murine enteritis: Microbe-independent effects involving Akt and NF-kB suppression. *PLoS ONE*, *9*(5), 1–9. https://doi.org/10.1371/journal.pone.0097456

Wiendarlina, I. Y., & Sukaesih, R. (2019). PERBANDINGAN AKTIVITAS ANTIOKSIDAN JAHE EMPRIT (Zingiber officinale var Amarum) DAN JAHE MERAH (Zingiber officinale var Rubrum) DALAM SEDIAAN CAIR BERBASIS BAWANG PUTIH DAN KORELASINYA DENGAN KADAR FENOL DAN VITAMIN C. *Jurnal Fitofarmaka Indonesia*, *6*(1), 315–324. https://doi.org/10.33096/jffi.v6i1.464

Xu, T. J., & Reichelt, A. C. (2018). Sucrose or sucrose and caffeine differentially impact memory and anxiety-like behaviours, and alter hippocampal parvalbumin and doublecortin. *Neuropharmacology*, *137*, 24–32. https://doi.org/10.1016/j.neuropharm.2018.04.012

Zhang, F., Zhang, J. G., Yang, W., Xu, P., Xiao, Y. L., & Zhang, H. T. (2018). 6-Gingerol attenuates LPS-induced neuroinflammation and cognitive impairment partially via suppressing astrocyte overactivation. *Biomedicine and Pharmacotherapy*, *107*(April), 1523–1529. https://doi.org/10.1016/j.biopha.2018.08.136

Zhang, S., Kou, X., Zhao, H., Mak, K. K., Balijepalli, M. K., & Pichika, M. R. (2022). Zingiber officinale var. rubrum: Red Ginger's Medicinal Uses. *Molecules*, *27*(3). https://doi.org/10.3390/molecules27030775

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