Physicochemical and Sensory Properties of Toast Bread Fortified with Ginkgo Biloba and Study of its Effect on Improving Types of Memory and Some Biochemical Indicators for University Students

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Abstract

This study aimed to evaluate the physical, chemical, and sensory properties of toast bread fortified with Ginkgo Biloba and to verify its effect in improving types of memory and some biochemical indicators for university students. For this purpose, twenty-five females and twenty-five males with hypomnesia, aged 18 to 25, were selected as the study sample, and it was conducted at the Faculty of Specific Education, Ain Shams University, and used tools, personal and socio-economic data, food habits, diet history, 24 hour recall, clinical signs, and applied the Battery of Cognitive Tests and Factorial Memory (BCTFM). Toast bread fortified with ginkgo in different proportions (10-15-20 g) was prepared, and chemical and physical evaluation was done for them. The results showed, ginkgo had a high level of antioxidants such as phenolics and flavonoids, as well as high activity against free radicals. On the other hand, bread fortified with 20 g ginkgo showed a significant improvement in chemical properties such as (protein, carbohydrates and fiber) and physical properties such as (weight, volume and density), than bread fortified with 15 and 10g, while its showed a greater improvement in the swelling power and PH respectively. They were sensory evaluated, and the bread fortified with 15 g of ginkgo was more acceptable than the others. The study sample was intervened with it for four months and the most important results showed: significant improvement in the level of antioxidant enzymes (GPX, CAT, and SOD) as well as Lipid profile such as (HDL and LDL) and the level of hemoglobin, red blood cells and folic acid. There was also a significant improvement in the level of memory in terms of Memory Span (auditory number, visual numbers, and audible letters) and visual memory (shape memory test, Building memory, and map memory) for all males and females after the dietary intervention at $P<0.05$. **Conclusion:** It was recommended to intake bread fortified with 15 g of ginkgo because of its significant effect in improving the level of memory, as well as ameliorating some biochemical indicators in the body.

Keywords: Memory impairment – Ginkgo – Physicochemical properties – Nutritional intervention – Biochemical indicators.

INTRODUCTION

The ability of the mind to encode, store, and retrieve material or knowledge as needed is known as memory. Amnesia or forgetfulness are common terms used to indicate memory loss **(Smith, 2014)**. The four primary types of memory are working memory, long-term memory, short-term memory, and sensory memory. Long-term memory is further divided into two categories: explicit (conscious) and implicit (unconscious) (**Liu et al., 2014, and Debashish et al., 2024)**. Through sensory memory, sensory information can be retained long after the stimulus has stopped. It is the capacity to remember specifics, such as a sound you heard momentarily or the sensation of someone's touch. Iconic memory, haptic memory, and echoic memory are the three types of sensory memory that are learned through sight, hearing, and touch **(Lazzarim et al., 2020)**. Use short-term span memory to temporarily store particular knowledge about an event. Short-term memory is not as persistent as long-term memory, but it is also less fleeting than sensory memory. Short-term memory is another name for primary or active memory (**Olsson and Poom, 2005 &Quire, 2009).**

Working memory is the tiny quantity of instantaneous knowledge that a person actively uses when completing cognitive activities. Working memory can be classified as short-term memory and is often used interchangeably with it, despite the fact that some individuals view it as a distinct type of memory **(Squire and Wixted, 2011)**. Our long-term memory houses the vast bulk of our memories and is important because it helps us recall important life experiences (**Schwabe and Wolf, 2010)**. Furthermore, we use our long-term memory to retrieve the information and actions that enable us to survive; this memory is classified into two main categories: implicit and explicit **(Adde et al., 2013and Ozge et al., 2023).** Damage to distinct regions of the brain or a lack of particular nutrients in the person's regular diet are two of the most common causes of hypomensia, or weak memory or forgetfulness **(Sorbo et al., 2010)**.

The elderly people are obviously affected, but children and young people may also experience it. Individuals with poor memory, particularly those in their youth, struggle to recall certain facts, information, or things, which impacts their scholastic performance **(Young et al., 2025).** Memory issues can be caused by things other than dementia or aging. For instance, memory issues can be brought on by illnesses like blood clots or depression; these issues typically resolve if the illness is effectively treated **(Alvares et al., 2010 and Natalia et al., 2025).** Memory problems (hypomensia) can be caused by a number of factors, such as head injuries like concussions, blood clots, tumors, or infections in the brain, thyroid, kidney, or liver issues, medication side effects, mental health conditions like anxiety and depression, alcohol or drug

abuse, sleep issues, low levels of essential nutrients, and inadequate consumption of healthful foods **Schacter, and Addis (2007).**

The maidenhair tree, or Ginkgo biloba, is a type of gymnosperm tree that originated in East Asia more than 290 million years ago. It is a large tree that typically reaches a height of 20 to 35 meters. It has an angular crown, long, somewhat erratic branches, and is typically deeply rooted **Hori, (2001) and USDA, (2016).** The fan-shaped, deep saffron-yellow leaves typically measure 5 to 10 cm, with veins extending out into the leaf blade **(Royer, et al., 2003)**. For many years, ginkgo has been used to treat blood abnormalities and memory issues. Ginkgo widens blood arteries and reduces blood clotting, which improves blood flow, according to studies done in lab settings. In addition, it has antidepressant properties, improves vascular and eye health, and aids in the treatment of dementia. Additionally, it might help against Alzheimer's disease, cancer, and heart disease **(Hatano et al., 2011) and (Nishimon et al., 2020).**

It is important to note that tests using Ginkgo biloba extract showed low toxicity to chronic or acute administration but no mutagenic or teratogenic effects. This occurs when used in excessive quantities, which can reach 100 g per day **(Blumenthal, 2000) and (Hang et al., 2019).** Studies have confirmed that ginkgo is non-toxic and that its use is safe. The antioxidants flavonoids, terpenoids, biflavones, lactones, and phenolic acids found in ginkgo leaves prevent free radicals from destroying DNA and other cells **(Wang et al., 2020**). They also contain vitamins, amino acids, fatty acids, and inorganic elements **Dong et al., (2020) and Ting (2025).**

Based on the data mentioned above, my study aims to investigate the Physicochemical and sensory properties of toast bread fortified with Ginkgo biloba and to examine its effect on improving types of memory and certain biochemical indicators in university students.

MATERIALS AND METHODS

A-Materials:

-The dry leaves of Ginkgo biloba were procured from a herbalist shop in Cairo, Egypt. While flour, sugar, salt, and margarine were obtained from a local market shop in Cairo, Egypt.

-The Battery of Cognitive Tests and Factorial Memory (BCTFM) and Wechsler Adult Intelligence Scale were obtained from the Anglo-Egyptian Library.

-The study sample consisted of students from the Faculty of Specific Education, Ain Shams University.

-All chemicals were obtained from El-Gomhouria Company for chemicals, medical instruments, and trading drugs, Cairo, Egypt.

B-Methods:

B.1-Chemical characterization of Ginkgo biloba:

The chemical composition and macronutrient makeup of G. biloba dry leaves (moisture, proteins, fat, carbohydrate, and ash) were determined using the difference **(AOAC, 1995).**

B.2-Phenolics and flavonoids content:

The Folin-Ciocalteu colorimetric test was used to determine the total phenolics in accordance with previously described techniques, the results were reported as milligrams of gallic acid equivalents (GAE) per gram of material (**Guimarães et al., 2009)**. Colorimetric test was used to evaluate total flavonoids; the results were expressed as milligrams of (+)-catechin equivalents (CE) per gram of sample **(Barros et al., 2010)**.

B.3-Antioxidant activity:

DPPH (2,2-Diphenyl-1-picrylhydrazyl) will be determined according to the method described by Ravichandran.

DPPH radical's scavenging capacity:

[(Ac – As / Ac) × 100] is the DPPH scavenging action (inhibition percentage). where Ac represents the control reaction's absorbance. As is the absorbance when the plant extracts are present **Ravichandran et al. (2012)**.

B.4-Preparation of bread:

With a few further adjustments, the bread samples were made in accordance with **Akubor and Obiegbuna, (2014)** instructions. The breads were made using a recipe that included 100g of flour (10, 15, and 20g) from Ginkgo biloba leaves (GBL) with two different samples each, 8g of sugar, 4g of salt, 20g of margarine, 50ml of water, and 2g of yeast. The dry ingredients were rubbed together after the components were weighed, and the water mixture and yeast were then combined in a basin. After creating a hole in the middle of the flour mixture, the dissolved yeast was added. This was fermented at 35°C under cover. The dough was manually kneaded until it was smooth and did not adhere to the top after the remaining water mixture, butter, sugar, and salt were added. The remaining dough was moved to the basin, covered, and let to prove at 35°C. After that, the proofed dough was carefully sprayed with oil, put into lightly oiled pans, and baked in a baking oven set to 220°C for 10 minutes.

B.5-Chemical analyses of bread fortified with Ginkgo:

Using the hot air oven drying method at 105°C to constant weight, the moisture content of the samples was ascertained. The AOAC methods were

then used to measure the contents of ash, crude fiber, protein (micro-kjeldahl, N x 6.25), and fat solvent extraction (**AOAC (2010)**. Calories were calculated using the factors of 4% carbohydrate, 4% protein, and 9% fat, and the total was then calculated.

B.6-Physical evaluation of bread fortified with Ginkgo:

A weighing balance was used to measure the bread's weight, and the seed displacement method was used to measure its volume **(Akubor and Obiegbuna, 2014).** Weight/volume was used to calculate the loaf density, and the **Adebowale et al., (2009)** method was used to measure the bread samples' swelling power. **Onimawo and Akubor, (2005)** were used to determine the pH of the wheat blends.

B.7-Sensory evaluation of breads:

A panel of 40 panelists, who were chosen at random from among the students in the Faculty of Specific Education at Ain Shams University and 20 teaching staff members with expertise in Nutrition and Food Science, evaluated each of the baked loaves. According to **(Adeboye et al., 2013),** the color, texture, taste, and flavor of the loaves were assessed using a 5-point Hedonic scale, with 1 denoting extreme dislike and 5 denoting extreme liking. The panelists were shown the sliced bread on white plates with three-digit codes. The assessment was conducted in a sensory evaluation facility with regulated airflow and illumination.

C- Subjects:

Fifty university students (25 females and 25 males) with hypomnesia (memory deficit), ages 18 to 25, and IQ scores of 90 on the Wechsler Adult Intelligence Scale are included in the study sample **(David, 2016).** For four months in a row, they received ginkgo-fortified bread every day as part of a nutritional intervention.

The following were applied to every student group:

C.1: Socioeconomic and Personal Data:

Name, sex, age, and social and economic status were all included, as determined by a scale that gauges the socioeconomic and cultural standing of Egyptian families **Ayman, (2018).**

C.2- Nutritional statues were assessed through:

The most crucial phase in assessing and monitoring a person in both normal and diseased conditions is determining their nutritional status, which in this study includes:

C.2.a- Food habits, diet history, and 24-hour dietary recall:

The required information was taken from students themselves, such as Ginkgo biloba /day, while diet history was used to know the extent of their

intake of ginkgo during the past year and their average intake per day, besides 24 hr. Dietary Recall was applied for 3 days pre and post dietary intervention. Food quantities were calculated and analyzed using food composition tables of the National Nutrition Institute and compared with the Recommended Nutrient Intake **(USDA, 2020).**

C.2.b- Dietary Intervention:

Dietary intervention was implemented daily for four months following an assessment of the nutritional status of students with hypomnesia. Based on the best results of the sensory evaluation, the dietary interventions in this study include bread supplemented with 15 g of Ginkgo biloba per day.

C.2.c- Anthropometric Measurements:

Weight (WT) to the nearest 0.1 kg and height (HT) to the nearest 0.5 cm are employed in this investigation. WT(kg)/HT(m)2 was used to determine the Body Mass Index (BMI), and a caliper was used to measure the skin fold in three separate locations: the triceps, lower back, and subscapular (TLS)) **(WHO, 2020)**.

C.2.d- Clinical signs:

(It was applied twice pre and post Dietary Intervention): Clinical signs included the (paleness of the face, brain injuries, difficulty sleeping, hair loss and white spots on the nails) between pre and post dietary intervention for students with Hypomnesia **(Jelliffe, 1966).**

D-Biochemical analyses:

D. 1- Antioxidant Enzymes Activities:

Ten volumes (w:v) were used to homogenize the hippocampus tissue. Superoxide dismutase (SOD) and glutathione peroxidase (GPx) activities were measured using ice-cold 50 mM potassium phosphate buffer (pH 7.4) with 1 mM EDTA. Samples were then homogenized in 10 vol (w:v) ice-cold potassium phosphate buffer 10 mM (pH 7.0) after being stored at -70C to evaluate antioxidant enzyme activities. The supernatant was used after the homogenate was centrifuged at 9609g for 10 minutes at 4C (**Sairam and Srivastava, 2002 and Li et al., 2015).**

D.2- Lipid profile:

The approach **(Allain et al., 1974),** was used to measure triglycerides and cholesterol in addition to low-density lipoprotein LDL-c and high-density lipoprotein HDL-c. The approach was used to measure it **(Fried et al., 1972)**.

D.3: Hemogram Parameters and folic acid level:

White blood cell (WBC) value and red blood cell and white blood cell counts were calculated using the biochemical analysis method of **Rodak (1995)**. The hemoglobin (Hb) concentration was determined using the method

outlined by **Cynthia et al. (1993)**. The folic acid level was determined using the Lucock technique **(Lucock, et al., 1989).**

E- Memory test:

Applying the Battery of Cognitive Tests and Factorial Memory (BCTFM), which consists of two components, is a crucial step in evaluating memory efficiency in children who struggle with memory **(Anwar and Walid, 2021).**

Part (1) - Memory Span, it includes three types of memory

a- Auditory Number Span Test, which includes 24 questions and the total score is 24 points.

b- Visual Number Span Test, which includes 24 questions, and the total score is 24 points.

c- Auditory Letter Span Test, which includes 24 questions, and the total score is 24 points.

Part (2) - Visual memory, which includes three types of memory

a- Shape Memory Test, which includes 32 questions and the total score is 32 points.

b- Building Memory Test, which includes 24 questions, and the total score is 24 points.

c- Map Memory Test, which includes 24 questions, and the total score is 24 points.

-Interpreting the total score of the test, according to the author, was by calculating all the scale scores for the two parts as follows

1-Degree from 111-152 means: They have a strong memory

2-Degree from 77 -110 means: They have an average memory

3- Degree from 1 - 76 means: They have a weak memory

F. Statistical Analysis:

Mean, Standard Deviation (±SD), and Duncan multipl range tests were employed for statistical analysis at the 0.01% level to compare means. Using the SPSS Windows package, do the T-test, Analysis of Variance (ANOVA), and Correlation Matrix (**Vavdallen, 1997).**

RESULTS AND DISCUSSION

B.1, B.2, and B.3 - Chemical characterization of Ginkgo biloba, Phenolics, flavonoids content, and Antioxidant activity.

The results presented in table (1), illustrated that.

The nutritional value of Ginkgo biloba leaves (GBL) was assessed, as demonstrated by Table 1's chemical characterization. The findings are provided in According to the difference, the most prevalent macronutrient was carbohydrates (68.3 g/100 g dw). Fat was the macronutrient that was present in

the least amount, giving this medicinal plant a more healthful appearance (3.6 g/100 g dw). Protein, ash, and vitamin B9 levels were 11.71, 10.2 g, and 55 µg/100 g dw, respectively. However, it was shown that each 1g GBL contained 51.3 mg of phenolics (gallic acid) and 11.3 mg of flavonoids (catechin).This result agrees with **(Eliana et al., 2013),** who showed that Ginkgo contains high levels of flavonoids and terpenoids, which are compounds known for their strong antioxidant effects. Additionally, the DPPH scavenging activity for aqueous extracts was 1.3 (EC50µg/ml) at a concentration of 50 µg/ml.

Table (1): Nutritional value, Phenolics, flavonoids and antioxidant of Ginkgo biloba dry leaves

Parameter	Amount (dry weight)
Ash /100g	9.2±0.02
Proteins /100g	11.71±0. 11
Carbohydrates /100g	68.3±1.5
Fat /100g	3.6±0. 09
B9 Folate/100g	55 µg
Phenolics (mg GAE/g)	51.3±1. 2
Flavonoids (mg CE/g)	11.3±0. 19
DPPH scavenging activity (EC50, mg/mL)	1.3±0. 07

EC50 values correspond to the sample concentration achieving 50% of antioxidant activity or 0.5 of absorbance in reducing power assay.
GAE- gallic acid equivalents
CE- catechin equivalents

B.5 and B.6- Chemical analyses and Physical evaluation of bread fortified with Ginkgo

Table (2) displayed the chemical properties of toast bread enhanced with ginkgo. The bread samples differ significantly from one another, according to the analysis of variance on all chemical analysis results. Except for moisture, which had the lowest percentage at 8.01%, sample C had the highest percentage of height in all chemical compositions, including ash, fat, protein, crude fiber, and carbohydrates, by 1.2, 2.56, 10.16, 2.7, and 76.02 percent, respectively. This could be because a significant portion of the water evaporated during oven preparation. Sample C is followed by Sample B, then A, in its chemical content. Dietary fiber acts as a bulking agent, increasing intestinal motility and wet fecal mass of feces **(Kamaljif et al., 2011).** The energy contents of food are related more to the fat, protein, and carbohydrate contents **(Onimawo and Akubor,**

2012). Ginkgo contains an amount of proteins, fats, fibers and carbohydrates **(Eliana et al., 2013)**, which is attributed to their high percentage in the second and third samples.

The same table displays the physical characteristics of toasted bread enhanced with ginkgo. Sample C's weight increased, but sample A's weight was the lowest. The three samples' levels of volume were nearly same in size, but sample C's height degree for density was higher, which is typical given the sample's increased weight. Additionally, all of the samples had acidic , while the pH values in samples A and B were similar, while sample C had a lower pH. On the other hand, the swelling power values for the three samples were close. These results agree with **Amoussa et al., (2021),** whose showed that the pH of ginkgo is acidic due to ginkgolic acids, and therefore when added to some products, it increases the acidity of this product, it was observed that swelling power were not significantly different in all sample. On the other hand **Kaur et al. (2007)** it reported that when compared to the native starch channels found in starch granules, the swelling power of acid-modified starches was always lower, during acid modification hydroxonium ion (H3O+) attacks glycosidic O2 atom and hydrolyse glycosidic linkage, acid therefore targets amorphous regions more often, this could causes decrease in swelling power. This explains the decrease in its rate when adding ginkgo to a greater extent in C sample than in B and A samples by a slight percentage.

Table (2): Chemical compositions and Physical properties of toast bread supplemented with Ginkgo

Sample		A (10 g) Ginkgo	B (15 g) Ginkgo	C (20 g) Ginkgo
Chemical compositions %	Moisture	11 ± 0.11^{a}	10.02 ± 0.21^{b}	8.01 ± 0.15^{c}
	Ash	0.7 ± 0.02^{c}	1.01 ± 0.1^{b}	1.2 ± 0.2^{a}
	Fat	2.3 ± 0.01^{b}	2.48 ± 0.09^{a}	2.56 ± 0.1^{a}
	Protein	8.3 ± 0.21^{c}	9.1 ± 0.17^{b}	10.16 ± 0.2^{a}
	Crude fiber	2.3 ± 0.03^{c}	2.4 ± 0.02^{b}	2.7 ± 0.01^{a}
	Carbohydrate	74.2 ± 1.03^{c}	75.13 ± 1.2^{b}	76.02 ± 1.91^{a}
	Weight (g)	250.15 ± 1.22^{c}	260.2 ± 2.81^{b}	271.1 ± 1.99^{a}
	Volume (cm3)	59.45 ± 1.33^{a}	60.2 ± 1.91^{a}	61.3 ± 1.83^{a}
	Density (g/cm3)	4.2 ± 0.02^{b}	4.32 ± 0.08^{b}	4.42 ± 0.01^{a}
	pH	6.29 ± 0.12^{a}	6.15 ± 0.09^{a}	5.55 ± 0.01^{b}
	Swelling power (g/g)	35.2 ± 1.2^{a}	35.9 ± 1.07^{a}	34.45 ± 1.62^{a}

Mean values along the same column with different superscript are significantly different ($p < 0.05$).

B. 7-Sensory evaluation of breads:

Sample 2, which was subsidized by 15 g of ginkgo, was better in texture and overall acceptability than other samples, but sample 1, which was subsidized by 10 g of ginkgo, was better in color, flavor, and taste than other samples, according to Table 3's sensory evaluation score test of ginkgo toast bread. Additionally, the sample that was subsidized by 15 g of ginkgo received the highest score, whereas the sample that was subsidized by 20 g of ginkgo received the lowest. The baking conditions (temperature and time), state of the bread components such as fibers, protein (gluten), starch and the amount of water absorbed during dough mixing, contribute to the final texture of bread **(Nishimon et al., 2020).**

The lack of general acceptance of a supported product by 25 g of ginkgo may be due to the increase in the amount of ginkgo used. **Ndife et al. (2011)** documented that baking properties of composite flours are impaired as well as the organoleptic attributes of their products due to dilution of gluten content, so they suggested the use of synthetic and organic improvers such as malt flavor and ascorbic acid in dough formulation to improve baking and sensory qualities. Therefore, the product was fortified with a new flavor, such as ginkgo.

Table (3): Sensory evaluation score test of Ginkgo toast bread

Sample	Color	Texture	Flavor	Taste	Overall acceptability	Total score (25)
A (10g) Ginkgo	4.8^{a}	4.2^{b}	4.5^{a}	4.8^{a}	4.5^{a}	22.8^{b}
B (15g) Ginkgo	4.7^{a}	4.8^{a}	4.3^{b}	4.7^{a}	4.6^{a}	23.1^{a}
C (20g) Ginkgo	3.8^{b}	4.1^{c}	3.4^{c}	3.9^{b}	4.2^{b}	19.4^{c}

Mean values along the same column with different superscript are significantly different ($p < 0.05$).
Breads were evaluated on a 5-point Hedonic scale (1=dislike extremely and 5= like extremely).

C-Subjects:

C.1-Personal data and socio-economic data:

According to the socioeconomic scale, all samples had poor social and economic levels (**Ayman, 2018)**. This means that the lack of memory may be due to reasons related to the lack of social and economic level. This is confirmed by the study of **Samia, (2023)**, which indicated that the non-verbal IQ and the total IQ and cognitive between children who belong to families with a high socioeconomic level and children who belong to families with a low socioeconomic level were high in favor of the former.

C.2. Nutritional Status Results:

C.2.a and C.2.b: Food habits diet history and 24hr. dietary recall and dietary intervention. These results are shown in tables 4 and 5.

To make sure the sample didn't intake enough ginkgo before to the dietary intervention, all of these questionnaires were used. The Ginkgo biloba / day intake of university students with hypomnesia before and after dietary intervention was displayed in Table (4). It revealed that, on average, before the dietary intervention, male students consumed 0.04 g of ginkgo biloba per day, whereas female students consumed 0.3 g. While post dietary intervention was (15.5 and 15.2 g) respectively, and there was a statistically significant increase between pre and post-dietary intervention. .

Table (4): Intake Ginkgo biloba/day among university students with Hypomnesia pre and post dietary intervention

Groups	Ginkgo biloba g/day	
	Pre dietary intervention	Post dietary intervention
Female (25students)	0.3	15.5
Sig.	*0.00	
Male (25students)	0.04	15.2
Sig.	*0.00	

*P< 0.01

According to the results of Food Habits, Diet History, and 24-hour Dietary Recall, the dietary intervention of Ginkgo toast bread for all samples (180g /day for the intervention group was for 120 days. Table (5) illustrates the nutritional value analysis of Ginkgo toast bread for all samples. The result showed that, 180 g of form contains Energy, Protein, Fat, Cho, Folate, Thiamin, Selenium, Sodium, and total polyphenols (Phenolics+ Flavonoids) by (18.9, 24.18, 35.4, 39.3, 82.3, 0.34, 76.7, 110.8, and 50.8) respectively from RDA compared to RDA **USDA, (2020).**

The highest percentages, which were roughly more than half of the RDA, were found in thiamin, folate, selenium, and total polyphenols. These results are consistent with **(Vanbeek and Montoro, 2009)** study, which showed that 100 g of ginkgo leaves contains polyphenols equivalent to 25 mg.In addition to agreeing with the **Brenner, et al., (2005)** study, which showed that ginkgo biloba contains many antioxidants and also contains a high percentage of folate.

Table (5a): Nutritional value analysis of Ginkgo toast bread for all samples

Nutrient	Quantity	Energy (Kcal)	Protein (g)	Fat (g)	Car (g)	Folate B9 (µg)
Ginkgo toast bread	**180 g**	399	18	20	51	329.5
% RDA		18.9	24.18	35.4	39.3	82.3

Table (5b):

Sodium (mg)	Selenium (µg)	Thiamin B1 (mg)	Phenolics (mg)	Flavonoids (mg)
5.1	42.2	1.1	8.9	3.8
0.34	76.7	110.8	Total polyphenols 12.7 50.8	

USDA, 2020

C.2.c- Anthropometric Measurements:

As shown in table (6), both male and female students in the sample study had normal height and weight in relation to standard measurements **(WHO, 2020),** before and after the dietary intervention. Additionally, there was no statistically significant difference in weight, height, or BMI between males and females before and after the dietary intervention. All females experienced overweight before and after the dietary intervention, while males had overweight before but had normal weight after the dietary intervention. This may be due to the difference in muscle composition between the bodies of males and females, as well as to the practice of sports by males compared to females, which led to a slight weight loss for males compared to females who gained a slight weight after the nutritional intervention. Female had a larger amount of fat than male, while a male's body contains more muscles than a female, and therefore a small amount of fat in his body will be converted into energy to feed these muscles, while a female had fewer muscles that consume the existing fat **(Barreira et al., 2011).**

There was a statistically significant difference for females at ($p=0.02$) by 19 and 21 mm, respectively, but no statistically significant TLS for males before or after the food intervention. This indicates that all samples had normal body fat percentages before and after the nutritional intervention. A caliper was used to measure the skin folds in three separate areas, including the subscapular, lower back, and triceps. For females, the optimal range is between 16 and 22 mm, the thinnest is less than 16 mm, and the obese are more than 22 mm. The ideal male body weight is less than 12 mm, obesity is greater than 21 mm, and normal range fat is between 12 and 21 mm **(Fields, 2002).**

Table (6): Average measurement of Physical standards (pre and post dietary intervention) for the study sample

Groups	Weight (kg)		Height (cm)		**BMI %		***TLS (mm)	
	Pre	Post	Pre	Post	Pre %	Post %	Pre	Post
Female (25 students)	71.4	72.7	166	166	25.96	26.4	19	21
Sig.	0.176		0.181		0.092		0.02*	
Male (25 students)	73.3	70.1	171	171	25.1	24	21	20
Sig.	0.172		0.121		0.081		0.061	

*P< 0.05
**BMI= Body mass index
***TLS= Measure skin fold by average for triceps ,Lower back and sub scapular

C.2.d- Clinical signs: (It was applied twice pre and post Dietary Intervention):

Table (7) compares the clinical indications of hypomnesia in students before and after nutritional intervention. These signs include paleness of the face, brain damage, difficulty sleeping, hair loss, and white spots on the nails.

It showed a noticeable improvement for all samples, whether female or male, in both paleness of the face, difficulty sleeping, hair loss, and white spots on the nails post than pre dietary intervention for students with Hypomnesia. Except for brain injury, the percentage remained the same before and after the intervention. The percentage of improvement for both (paleness of the face, difficulty sleeping, hair loss and white spots on the nails) before the dietary intervention for females were (16, 20, 40 and 8%) respectively, while after dietary intervention were (12, 0, 16 and 4%) respectively. On the other hand, the percentage of improvement for males were (8, 16, 36, and 16%) respectively, while after dietary intervention were (0, 0, 20, and 8%) respectively. The rate of improvement for females was higher than for males, and this may be due to the extent of females' commitment to treatment compared to males during the intervention.

This result in line with **(Werner et al., 2009),** who confirm that people with Hypomnesia suffer from hair loss, paleness of the face, difficulty sleeping, and brain injuries. Females are more improved than males in terms of memory levels. This may be due to the levels of the hormone "estradiol," which is one of the "estrogen" hormones - affects learning and memory, and it is more abundant in females than in males **(Kucuk et al., 2008).**

Table (7): Clinical sings (paleness of the face, brain injuries, difficulty sleeping, hair loss, and white spots on the nails) between pre & post dietary intervention for students with Hypomnesia

Groups	Paleness of the face		Brain injuries		Difficulty sleeping		Hair loss		White spots on the nails	
	Pre %	Post %	Pre %	Post %	Pre %	Post %	Pre %	Post %	Pre %	Post %
Female (25students)	16	12	8	8	20	0	40	16	8	4
Sig.	0.088		0.067		0.049**		0.00*		0.261	
Male (25students)	8	0	0	0	16	0	36	20	16	8
Sig.	0.039**		0.193		0.011**		0.043**		0.361	

*P< 0.01
**P< 0.05

D-Biochemical analyses:

D.1, D.2, and D.3 Antioxidant Enzyme Activities, Lipid profile, Hemogram Parameters, and folic acid level. Tables 8, 9, and 10 illustrate these results.

The results in Table (8), under the title, antioxidant enzymes activities superoxide dismutase (SOD), glutathione peroxidase (GPx) and catalase (CAT) for student's sample, indicate that there were statistically significant differences before and after the dietary intervention for the female's research sample for both GPX, CAT and Sod at P< 0.01 for the first and at P< 0.05 for the remaining two. In contrast, there were statistically significant differences before and after the dietary intervention for the male's research sample, in both GPX and CAT at P< 0.01, besides at P< 0.05 in SOD.

This result accord with **(Jerome et al., 2023)** who showed that Ginkgo biloba supplement significantly reduced oxido-inflammatory and apoptotic effects by increasing CAT, SOD, GSH levels and decreasing MDA levels. Ginkgo biloba supplementation significantly increased vascular antioxidant enzymes (SOD and CAT) and GSH, preventing the release of free radicals **(Carmine et al., 2021).** Furthermore, Ginkgo biloba extract treatment significantly reduced cognitive impairment in mice and its antioxidant content helped improve the structure and function of cerebral blood vessels by increasing their density and diameter, leading to improved cerebral blood flow **(Ting et al., 2025).**

Table (8): Antioxidant enzymes activities, superoxide dismutase (SOD), glutathione peroxidase (GPx) and catalase (CAT) for the student's sample

Groups	Female (25 students)						Male (25 students)					
Analysis	GPx (µmol/ min/mg)		CAT (µmol/min/ mg)		SOD (µmol/min/ (mg		GPx (µmol/ min/mg)		CAT (µmol/min/ mg)		SOD (µmol/min/ mg)	
	Pre	Post	pre	post	pre	post	Pre	Post	pre	post	pre	Post
	13.12± 0.17	25.11± 1.13	12.22± 0.04	21.91± 1.33	6.65± 0.39	13.76± 0.56	11.98± 0.77	27.39± 1.97	9.22± 0.51	20.71± 0.86	5.12± 0.72	10.11± 0.59
Sig.	*0.00		**0.03		**0.02		*0.00		*0.00		**0.03	

*P< 0.01
**P< 0.05

According to table (9), which shows the impact of ginkgo biloba on the lipid profile of students in sample research, there was no statistically significant difference in triglycerides for males and females between before and after dietary intervention. For males exclusively, however, there were statistically significant variations in cholesterol levels before and after the dietary intervention. Additionally, it demonstrated that HDL-c and LDL-c levels in the research sample's male and female participants differed statistically significantly at the P<0.05 level before and after dietary intervention. This is consistent with studies showing a modest rise in HDL levels when intake of Ginkgo biloba **Naidu et al., (2002)**. These results were in line with the results study of **Sandeep et al., (2019),** which aimed to evaluate Ginkgo biloba extract, when used as an "addon" therapy with metformin, significantly reduced TG, LDL-c, and CRP levels, while increasing HDL-c, thereby enhancing the overall lipid profile and inflammatory markers.

While the results indicated that there was no statistical significance before and after dietary intervention for both males and females on triglycerides. However, there were statistically significant differences in cholesterol before and after the dietary intervention for males only. These results concur with **(Yang et al., 2016),** who observed that the study found that individuals treated with GKB showed a significant decrease in triglycerides and LDL-c levels, while also experiencing an increase in HDL-c levels and a non-significant decrease in total cholesterol. Ginkgo biloba reduces serum cholesterol levels without significantly altering triglyceride and high-density lipoprotein levels **(Arun et al., 2004 and Ting et al., 2025).**

Table (9): The effect of Ginkgo biloba on Lipid profile for the students have a sample study

Parameters / Groups	Cholesterol	Triglycerides	HDL-c	LDL-c
	mg/ dl			
Female (25 students) Pre-dietary intervention	107.1 ±4.11	55.16 ±1.04	61.12 ±2.29	39.9 ±1.86
Female (25students) Post dietary intervention	101.71 ±2.26	54.71 ±2.97	70.21 ±2.03	20.5 ±0.83
Sig.	0.125	0.351	*0.014	*0.023
Male (25 students) Pre-dietary intervention	116.41 ±2.11	62.33 ±2.22	59.63 ±3.81	43.9 ±2.12
Male (25 students) Post dietary intervention	105.21 ±2.26	45.11 ±3.48	73.56 ±4.14	22.7 ±0.55
Sig.	*0.036	0.135	*0.038	*0.013

*P< 0.05

Table (10) provides an explanation of the complete blood count and folic acid level, demonstrating that the HGB level for both males and females in the research sample differed statistically significantly before and after dietary intervention with bread enriched with ginkgo. However, there were no statistically significant variations in their WBC counts. However, following nutritional intervention, the RBC levels in the research sample significantly improved for males compared to females, by 4.9 and 4.1 µL/106×, respectively. The improvement of red blood cells in males compared to females may be due to the presence of higher androgen hormones in the male body, which stimulates the body to produce a larger amount of red blood cells compared to females **(Hatton et al., 2023).** This results in a line with **Ruhi, (2021),** who clearly Red blood cells (RBC), packed cell volume (PCV), haemoglobin (HGB), mean corpuscular haemoglobin (MCH), and mean corpuscular haemoglobin concentration (MCHC) all improved in rats supplemented with gingko biloba extract. **Cinar et al., (2019)** showed effect of Gingko Biloba extract made a slight improvement in the blood levels of RBC, HCT, HGB, MCV, MCH, and MCHC. Flavonoids, antioxidants, and terpenes found in ginkgo biloba are medicinal herbs that inhibit platelet activation factor (**Maltas et al., 2011),** due to their anti-inflammatory, immunomodulatory, and neuroprotective qualities **Vellas et al., (2012) and Hong et al. (2019)** found that ginkgo extract supplements increased red blood cell and hemoglobin levels.

This improvement was attributed to ginkgo's flavonoids and terpenoids, the main bioactive components that improve these levels **Jing et al., (2009).**

Furthermore, all samples showed measurable increases in folic acid levels before and after the dietary intervention at a significance level P<0.05. For females, these improvements were 3.8 and 8.17 ng/mL before and after the dietary intervention, respectively, while for males, they were 5.5 and 10.4 ng/mL before and after the dietary intervention. Folate is a crucial nutrient for the healthy growth, development, and operation of your nerve and red blood cell tissues (**Li et al., 2016).** Blood and red blood cells are tested for folate levels using the folate blood test **Bibbins et al., (2017).** While **Wald et al., (2018)** reveal that low folate can damage nerves and stop red blood cells from forming normally. Folate levels can be impacted by a variety of illnesses, medications, and food choices **(Zheng and Cantley, 2019).**

Table (10): The effect of Ginkgo biloba on Blood levels of RBCs, WBCs, HGB, and Folic acid level for the students have a sample study

Parameters / Groups	HGB (g/dL)	WBCs (µL)	RBCs /µL) (×10^6	Folic acid level (ng/mL)
Female (25 students) Pre-dietary intervention	8.51 ±0.92	6615.12 ±23.12	3.31 ±0.11	3.8 ±0.23
Female (25 students) Post dietary intervention	11.52 ±0.73	6731.23 ±32.13	4.1 ±0.03	8.17 ±1.12
Sig.	*0.012	0.427	*0.025	*0.013
Male (25 students) Pre-dietary intervention	9.19 ±0.42	5687.15 ±44.01	3.21 ±0.31	5.5 ±0.31
Male (25 students) Post dietary intervention	12.01 ±0.93	5834.52 ±38.98	4. 9 ±0.14	10.4 ±1.13
Sig.	*0.026	0.212	*0.027	*0.032

*P< 0.05

E- Memory test:

A battery of cognitive tests and factorial memory (BCTFM) was used to assess memory weakness in students before and after nutritional intervention **(Anwar and Walid, 2021)**. It is displayed in figures 1 and 2 as well as Table 11. The results showed that the total test score for (memory span and visual memory), together for the females in the research sample was 63 degrees when applying the memory test BCTFM, while for the males in the research sample it was 65 degrees. This shows that there is no statistical significance for them

before the dietary intervention, which explains that the entire sample suffers from weakness in memory and recollection according BCTFM test **.**

After the dietary intervention for all samples, the results showed an improvement for all sample in memory and concentration according to the BCTFM test for females and males. The females' score on the test for both (memory span and visual memory) together was (132 and 132 degrees) for females and males, respectively. There were statistically significant differences post dietary intervention compared to before at $P< 0.01$ for all samples, and there were statistically significant differences between males and females at $P< 0.01$ in favor of females after dietary intervention by bread fortified with Ginkgo. This improvement in females may be due to the levels of the hormone estradiol, which is one of the estrogen hormones that affects learning and memory, and is more abundant in women than in men **(Bennett et al., 2013)**. Levels of this hormone begin to decline in the post-menopausal stage, which in turn affects memory levels in women, but its levels remain better than men at the same age **(Husain et al., 2014)**. And agrees with **(Tian et al., 2013) and Pagotto et al., (2024)**, who showed Ginkgo improves concentration and mental focus, and this is due to the antioxidant content. On the other hand, it is consistent with **(Zhou et al., 2019),** who indicated that Ginkgo advantageous effects on improving cognition are seen in clinical groups with cognitive impairment, including those suffering from Alzheimer's or cerebrovascular illness. (**Wei et al., 2021),** who explained that, in numerous neurodegenerative illnesses, ginkgo biloba extract prevents memory loss, which serves as a neuroprotective function.

The results in this study agree with **(Olga et al., 2006),** who examined the effect of 20 mg/kg Ginkgo biloba extract on spatial memory by administering the drug in the interval between training and testing, and showed that Ginkgo may promote learning of spatial information. In addition to showing neuroprotective properties through the inhibition of cytosolic phospholipase **(Zhao et al., 2011),** Ginkgo biloba is a medicinal herb that has been utilized as an anti-dementia medicine. It also has a protective effect against the advancement of Alzheimer's disease and enhances memory and cognitive function **(Verma et al., 2020),** this due to it has various beneficial pharmacological effects, such as improving cerebral blood flow, inhibiting oxidative stress, and modifying neurotransmission and neuroplasticity **young et al., (2025).** Besides study **(Khalil et al., 2023)** used treatments by ginkgo to improve memory and cognitive performances in the Y-maze in rats, and may provide a more effective strategy to lessen neurodegeneration in Alzheimer's disease. Furthermore, **Debashish et al. (2024)** indicated that taking Ginkgo biloba extract has a significant effect in improving and treating cognitive decline.

Table (11): Results of applying the Battery of Cognitive Test and Factorial Memory (BCTFM) for students suffering from weakness in memory pre and post dietary intervention

Status	Female (25 students)						Male (25 students)					
	Pre-dietary intervention											
Types of Memory	Memory Span			Visual memory			Memory Span			Visual memory		
	Auditory Number Span Test	Visual Number Span Test	Auditory Letter Span Test	Shape Memory Test	Building Memory Test	Map Memory Test	Auditory Number Span Test	Visual Number Span Test	Auditory Letter Span Test	Shape Memory Test	Building Memory Test	Map Memory Test
Degree Test	11	10	9	12	10	11	10	11	10	11	12	11
Total degree test	63						65					
Sig between female and male	0.124											
	Post dietary intervention											
Types of Memory	Memory Span			Visual memory			Memory Span			Visual memory		
	Auditory Number Span Test	Visual Number Span Test	Auditory Letter Span Test	Shape Memory Test	Building Memory Test	Map Memory Test	Auditory Number Span Test	Visual Number Span Test	Auditory Letter Span Test	Shape Memory Test	Building Memory Test	Map Memory Test
Degree Test	22	20	22	30	18	20	20	21	19	28	18	17
Total degree test	132						123					
Sig between female and male	*0.00											
Sig. between pre- and post dietary intervention	*0.00											

*P< 0.01

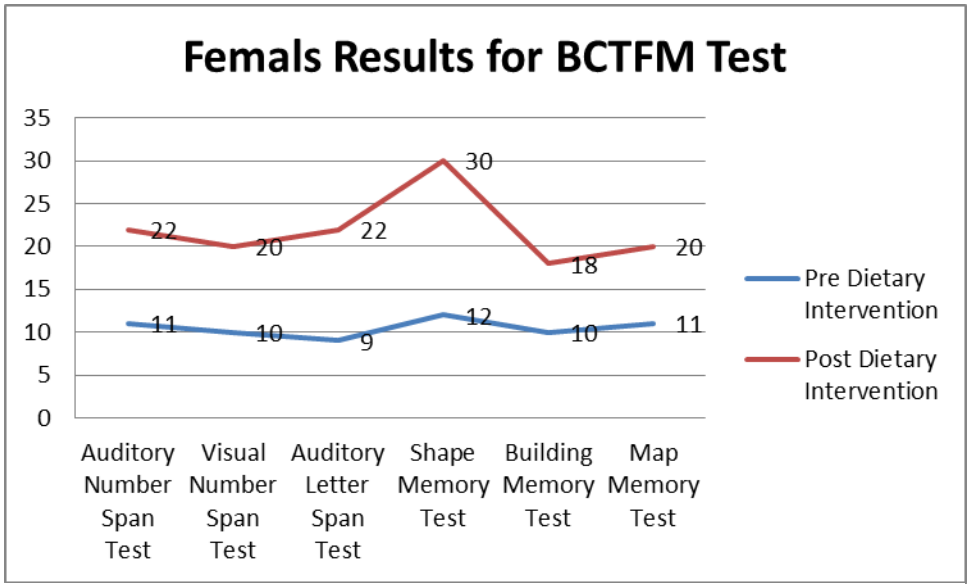

Figure (1): Results of applying (BCTFM) test for females suffering from weakness in memory pre and post dietary intervention

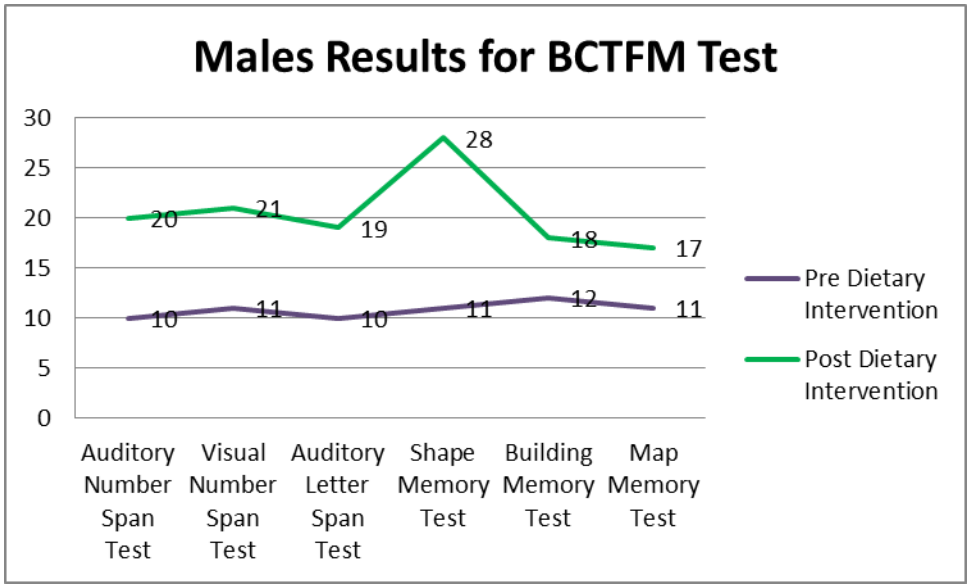

Figure (2): Results of applying (BCTFM) test for males suffering from weakness in memory pre and post dietary intervention

CONCULUSION

Young people now frequently suffer from hypomnesia, particularly college students. Their academic performance may be impacted, and diet is a key factor in addressing this issue. The study's most significant findings demonstrated that eating 15 g of ginkgo every day, added to foods like toast or other foods, helps people with hypomnesia with their memory. It also improved some biochemical processes, including the levels of oxidation enzymes, HDL, LDL, hemoglobin, and red blood cells.

Ethical approval

This study is in agreement with the ethical guidelines of the Declaration of Helsinki, and it follows the ethical standards of the Faculty of Specific Education, Ain Shams University
(IRB number: 25-HED 2 -2024).

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الملخص العربي

الخصائص الفيزوكيميائيه والحسيه لخبز التوست المدعم بالجنكة بيلوبا ودراسة تأثيرها علي تحسين أنواع الذاكرة وبعض المؤشرات البيوكيميائيه لطلاب الجامعة

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هدفت هذه الدراسة الي تقييم الخصائص الفيزيائية والكيميائية والحسية لخبز التوست المدعم بالجنكة بيلوبا والتحقق من تأثيره في تحسين أنواع الذاكرة وبعض المؤشرات البيوكيميائية لطلاب الجامعة. ولهذا الغرض، تم اختيار خمس وعشرين أنثى وخمسة وعشرين ذكرًا يعانون من ضعف الذاكرة، تتراوح أعمارهم بين 18 و25 عامًا، كعينة للدراسة. وقد أجريت الدراسة في كليه التربية النوعية جامعه عين شمس. وقد استخدمت الدراسة الأدوات الأتية: استمارة البيانات الشخصية للطالب واستمارة العادات الغذائية واستمارة التاريخ الغذائي واستمارة المأخوذ اليومي لأربع وعشرون ساعة واستمارة العلامات الإكلينيكية وبطارية الاختبارات المعرفية والذاكرة العاملة لضعف الذاكرة. وتم صنع خبز توست مدعم بالجنكة بنسب مختلفة (10–15–20جرام) وتم عمل التقييم الكيميائي والفيزيائي لهم. وأظهرت أهم النتائج ارتفاع مستوي الجنكة من مضادات الأكسدة مثل (الفينولات والفلافونويد) وكذلك نشاط عالي مضاد للجذور الحرة. ومن جهة أخري أظهر الخبز المدعم ب 20 جم جنكه تحسناً كبيراً في الخصائص الكيميائية مثل (البروتين والكربوهيدرات والالياف) والخصائص الفيزيائية مثل (الوزن والحجم والكثافة) ويليها المدعم ب 15 ثم 10 جرام بينما أظهر المدعم ب 15 و10 جم تحسناً أكبر في مستوي الارتفاع ودرجه الحموضة على التوالي. وقد تم التقييم الحسي لهم وكان الخبز المدعم ب 15 جم جنكه أكثر قبولا من الاخرين. وتم التدخل به لعينه الدراسة لمده اربعه أشهر، واظهرت اهم النتائج تحسناً كبيرا في مستوي انزيمات مضادات الأكسدة (SOD ،GPX, CAT) وكذلك مستوي دهون الدم لكلاً من (البروتينات الدهنية عالية ومنخفضه الكثافة) ومستوي الهيموجلوبين وكرات الدم الحمراء والفوليك اسيد. وكذلك تحسناً كبيراً في مستوي الذاكرة من حيث مدي الذاكرة (الارقام المسموعة والارقام المرئية والحروف المسموعة) والذاكرة البصرية (اختبار ذاكره الشكل والذاكرة البنائية وذاكره الخرائط) لكل العينة ذكور وإناث بعد التدخل الغذائي عند مستوي دلاله P<0.01. **الخلاصة:** يوصي بتناول الخبز المدعم ب 15 جم جنكه لما له من تأثير كبير في تحسين مستوي الذاكرة وكذلك تحسين بعض المؤشرات البيوكيميائيه في الجسم.

الكلمات المفتاحية: ضعف الذاكرة– الجنكة – الخصائص الفيزوكيميائيه – التدخل الغذائي – المؤشرات البيوكيميائه.