Efficiency of Some Natural Antioxidants on Memory Status in Children with Learning Disabilities

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Abstract

Memory is a quintessential human ability which the nervous system can encode, store, and retrieve a variety of information. Polyphenols are powerful antioxidant and regular intake of polyphenol-rich observed improvements in learning, working, spatial, acquisition and retention of memory. The current study was conducted to investigate the effectiveness of administration diets rich in some natural antioxidants on the abilities of memory and nutritional status for primary school children with learning disabilities. Twenty-seven children in age from (7 – 13) years in the primary school were diagnosed by the psychologist and their teachers were enrolled in the study. Intelligence tests (Stanford Penny), learning disabilities measure (Memory), Personal data, Anthropometric measurements and nutrition assessment were used before and after diets intervention. The application of food intervention was carried out by providing one category of meals daily, meal 1 contains (vanilla biscuit with yellow cornmeal + fruit cake with cocoa jelly), meal 2 contains (chocolate cupcake with yellow cornmeal +fruit cake with red beet roots jelly) and meal 3 contains (chocolate peanut butter biscuits+ vegetables salad) for 3 months frequency. These meals contain polyphenols (quercetin, caffeic acid, P-coumaric acid and ferulic acid).

It was observed that prepared diets rich in some antioxidants had highly significant increase (P≤ 0.01) in the mean value of memory (19.25±3.64) as compared to before test (11.66 ± 1.38), also improved some nutritional and behavioral problems. It could be concluded that dietary intervention rich in polyphenols could improve and enhance memory status in children with learning disabilities.

KeyWords:memory, polyphenols, quercetin, caffeic acid, p-coumaric acid, ferulic acid.

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Introduction:

Memory is composed of multiple systems that have different operating principles and different neuro anatomy and can encode, store, and retrieve a variety of information **(Squire, 2009).** Psychologists have found that memory includes three important categories: sensory memory (is not consciously controlled), short-term memory (can only hold limited information) and long-term memory (can store an indefinite amount of information) **(Zlotnik and Vansintjan., 2019).**

Phenolic acid and flavonoids are powerful antioxidants. These compounds are embedded in the human diet and originate from plants like fruits, vegetables, cereals, and coffee **(Abbas et al., 2017).**A large number of dietary (polyphenol-rich foods) intervention studies in human subjects **(Macready et al., 2009)** and animals **(Rendeiro et al., 2009),** in particular grape, tea, cocoa and blueberry **(Bakoyiannis et al., 2019),** provides a positive impact on cognitive outcomes and observed improvements in learning, working, spatial, acquisition and retention of memory **(Kim et al., 2014 and Gonzalo et al., 2022).**Quercetin (QT), a plant-based flavonoid, has exhibited remarkable effects against neurodegeneration and inflammation in models of dementia (Olayinka et al., 2022), as well as preventing spatial learning and memory deficits provoked by chronic stress in rats **(Mohammadi et al., 2014).**

Caffeic acid is a phenolic compound that has been reported to possess potent antioxidant and neuroprotective properties **(Deshmukh et al., 2016)** and improved learning, memory and protecting mice against the decline in spatial cognition **(Morroni et al., 2017).**

P-coumaric acid (P-CA), a phenolic acid, is widely distributed in vegetables and fruits, P-CA has confirmed a protective role against oxidative stress and inflammation in various diseases and reported to possess free radicle scavenging and neuroprotective action, protect against depression and memory impairment **(Yu et al., 2022),** and enhancing cognitive impairment induced by cerebral ischemia or neuroinflammation **(He et al., 2021 and Yu et al., 2022).** Ferulic acid (FA), a phenolic compound commonly found in a range of plants, has emerged various properties including anti-inflammatory and neuroprotective effects **(Wang et al., 2017).** FA inhibits D-gal-induced Acetylecholinesterase activity, oxidative stress, neuroinflammation and neurodegeneration, and consequently ameliorates memory impairment **(Yang et al., 2016).**

Childhood with learning disabilities is associated with adverse outcomes even in adult age in education, employment, and psychological well-being **(Aro et al., 2019).** Therefore, this research was conducted to investigate the effectiveness of administration diets rich in some natural antioxidants on the abilities of memory and nutritional status for primary school children with learning disabilities.

Materials and Methods

Materials

1- Ingredients of prepared Diets (Fruit Cake with cocoa and red beet roots jelly, vanilla biscuit with yellow cornmeal, Chocolate Cupcake with yellow cornmeal, Chocolate peanut butter biscuits, Vegetable Salad) were purchased from the local market.

2- Subjects: Twenty-seven children in age from (7 – 13) years in the primary school (Al-Azhar Primary Institutes) were diagnosed by the psychologist and their teachers, were enrolled in the study.

Methods:

A- Anthropometric measurements: The height of the adults was measured to the nearest 0.1 cm. The weight in kilograms, was measured by using procedure described by (Jellifee, 1966) using bathroom scales. Body Mass Index (BMI) – for-age is a number calculated from a child's weight and height and evaluated using an age and sex specific growth chart **(Must and Anderson, 2003).**

B- Dietary assessment for the students were evaluated including (the knowledge was obtained from their parents): Diet History Method: Evaluating foods and quantities which child eats during (day, week, month and year). 24 hour recall form for one week (before and after diets intervention) were taken then were analyzed by food composition table, at the National Nutrition Institute (NNI, 2006) and compared to their recommended dietary allowance according to **(Dietary Guidelines for Americans 2020- 2025).** Form of dietary habits (for family and children) were carried out.

1- Diets preparation for the case study: The application of food intervention was carried out by providing one category of meals daily, meal 1: (Vanilla biscuits with yellow cornmeal + Fruit cake with cocoa jelly), meal 2: (Chocolate cupcake with yellow cornmeal + Fruit cake with red beet roots jelly) and meal 3: (Chocolate peanut butter biscuits+ Vegetables salad) for 3 months.

Method of preparation the different diets formula: all diets were prepared with conventional methods with some modifications as follows:

Meal (1): vanilla biscuit with yellow cornmeal: all ingredients were weighed, mixed (corn flour 70g, Honey 40 g, butter 30 g, egg 15g, vanilla ½ g, baking powder 1g and salt ½ g) then manually kneaded. Dough was cut into verities shape and baked at 180˚C for about 10 minutes and left to cool at room temperature **(Al-Marazeeq and Angor, 2017).**

Fruit cake with cocoa jelly: all ingredients were weighted, (dates 50g, plum 100g, apple 50g, strawberry 50g, gooseberry 100g, orange 50g, peanuts 25g, cocoa 10g, honey 85g and gelatin 15g), washed, peeled and cut into small pieces, then stacked, covered with gelatin and placed in the freezer until it freezes. The cocoa jelly was prepared with a large spoonful of gelatin for each cup of water and stirred well, then raised on the fire until it boiled, cooled and sweetened with honey and cocoa stirring well, then pouring it over the frozen fruits and placing in the freezer again until the jelly freezes.

Meal (2): Chocolate cupcake with yellow cornmeal:

the method was conducted according to **(Hassan et al, 2020**) with some modifications, all ingredients were weighed (corn flour 50g- cocoa 2g- peanuts 5g- vanilla ¼ - salts ¼ - baking powder ½ g) sifted together in a medium mixing bowl. Egg 20g was mixed for 1 minute by a handled electric mixer, corn oil 20g and milk 25g added to egg and mixed then honey 20g was added and mixed together for 1 minute. All mixed ingredients were added to dried mixture and poured into bake cups paper then baked at 180°C for 15 min. Baked cupcake cooled at room temperature, then cover the surface with cocoa mixed with honey 15g and peanut.

Fruit cake with red beet roots jelly: all ingredients were weighed (dates 50g, chokeberry 5g, banana 50g, grape 50g, strawberry 150g, gooseberry 100g, orange 25g and peanuts 25g- honey 45g- gelatin 15g- dried red beet roots 5g), washed, peeled and cut into small pieces, stacked, covered with gelatin and placed in the freezer until it freezes. The beet jelly was prepared with a large spoonful of gelatin for each cup of water and stirred well, then raised on the fire until it boiled, cooled and sweetened with honey and beets stirring well, then pouring it over the frozen fruit and placing it in the freezer again until the jelly freezes.

Meal (3): Chocolate peanut butter biscuits: was carried out according **to (Al-Marazeeq and Angor, 2017)** with some modifications all ingredients were weighed, mixed (corn flour 60g, corn bran 4g, cocoa 5g, Honey 65 g, peanuts 25g, butter 25g, egg 15g, vanilla ¼ g, baking powder ½ g and salt ¼ g, white chocolate 20g) then manually kneaded. Dough was cut into verities shape and baked at 180˚C for about 10 minutes and left to cool at room temperature. Chocolate sauce was prepared after turning peanuts into butter. Two pieces of biscuits were pasted with peanut butter and covered with chocolate sauce prepared with cocoa, honey, and white chocolate were placed on the surface.

Vegetable salad: including, tomato 50g, cucumber 50g and carrot 70g were chopped into chunks red onion (20g) was chopped, dill (15g), watercress (20g) and coriander (20g) were finely chopped add salt (¼ g) and lemon (2g) **(Raiz, 2013).**

2- Sensory evaluation

- ***Cupcakes:*** Forty mothers and fathers of children under the study were asked to evaluate the prepared Cake for sensory quality attributes (appearance, texture, color, taste, odor, pore and overall acceptability) (Hassan et al., 2020).
- ***Biscuits:*** The samples were evaluated for desirability in appearance, color, moisture, texture, taste, flavor and overall acceptability using a 9-hedonic scale test as described by Larmond, (1991).
- ***Fruit cake with jelly:*** The samples were evaluated for desirability in appearance, color, texture, taste, odor, flavor and overall acceptability was evaluated according to (Grujić et al., 2007).

3- Chemical composition: The above-mentioned diets were chemically analyzed to determine the growth chemical composition According to **(A.O.A.C, 2020).** Total antioxidants (Quercetin, Caffeic acid, P-coumaric acid and Ferulic acid) were analyzed according to the method of **(Burda and Oleszek, 2001).**

D- Clinical Assessment:

1- Behavioral and physician tests: These tests were used to measure the behavioral indicators of developmental learning disabilities (Memory) for primary school students, including (9 items) from (37 axes) according to **(Elnagar and Salama, 2015).** Intelligence tests (Stanford Penny) were carried out according to **(Penny, 2011).**

Notes: Previous measure forms were used before starting the study and after 3 months from tested diet intervention.

E- Statistical Analysis: The data were expressed as mean ± standard deviation (SD). T test was used to compare results before and after the intervention study, P-value of <0.05 was considered statistically significant **(Sendore and Cochron, 1980).**

Results

Results in **Table (1)**show that intelligence quotient (IQ) for children with learning disabilities before diet intervention was (94.07 ± 3.63) with the minimum IQ was 88 while maximum IQ was 100. The effect of prepared diets rich in some natural antioxidants on abilities of memory in primary school children with learning disabilities was shown in **Table (2).** Children that fed in the prepared diets rich in some antioxidants had highly

significant increase (P≤ 0.01) in the mean value of memory (19.25±3.64) as compared to before test (11.66 ± 1.38).

There is no significant (p≤0.05) difference in weight for children with weakness memory before and after the tested diet as shown in **Table (3-A).** On the other hand, children with learning disability had highly significant (p ≤0.01) in height after feeding on the tested diets (133.03 ± 8.79 cm) as compared before the test (129.3 ± 8.74 cm). **Table (3-B)** showed that body mass index for age for normal weight children was 63% before diet intervention but was increased after diet intervention to 66.7%, obesity children before diet was 7.40% compared with after diet was 3.70%. No changes in underweight and overweight children before or after intervention diet.

Table (1): Intelligence Quotient for children with weakness memory

	Subject (N)	Minimum	Maximum	Mean± SD
IQ	27	88.00	100.00	94.07 ±3.63

SD: standard deviation.

Table (2): Effect of diets rich in some natural antioxidants on abilities of memory in children with learning disabilities

	Before				After			T	df	Sig.
	N	Min.	Max.	Mean	Min.	Max.	Mean			
Memory	27	9.00	15.00	11.66±1.38	11.00	25.00	19.25±3.64	11.80	26	0.000**

Data are expressed as means ± SD. **: highly significant differences at (P≤ 0.01).

Table (3-A): Anthropometric measurements for children with weakness memory

Parameters	Before	After	t	df	Sig.
Weight	29.81±1.77	30.87±6.32	0.921	26	0.365 (NS)
Height	129.3±8.74	133.03±8.79	9.952	26	0.000**

Data are expressed as means ± SD. **: highly significant differences at (P≤ 0.01).
NS: Non Significant.

Table (3-B): Body mass index for age for children with weakness memory.

Parameters	Before		After	
	N	%	N	%
Underweight	5	18.5%	5	18.5%
Normal	17	63%	18	66.7%
Overweight	3	11.1%	3	11.1%
Obesity	2	7.40%	1	3.70%

Table (4) revealed the appearance score for all tested diets ranged between 9.1-9.7. The texture score ranged between1 8.7-19.6. The internal color score ranged between 9.4- 9.7. The taste score ranged between 18.4-19.6. The odor score ranged between 18.9 -19.6. The moisture score ranged between 19.2-19.6. The pore score for Chocolate and peanut cupcake 18.1. The flavor score ranged between 18.6-19.6. Vanilla biscuits with yellow cornmeal, Chocolate Peanut Butter Biscuits, Fruit cake with beet jelly, Fruit cake with cocoa jelly and Chocolate and peanut cupcake, respectively. General acceptable degree of Vanilla biscuits with yellow cornmeal (97.8), Chocolate Peanut Butter Biscuits (93.55), Fruit cake with beet jelly (97.3), Fruit cake with cocoa jelly (95.45) and Chocolate cupcake with yellow cornmeal (95).

Table (5) showed the antioxidant contents in prepared diets, quercetin contents in meals was 50 mg, 50.7 mg and 50.1 mg for meal1, meal 2, meal 3, respectively. While caffeic acid contents in meals was 31.5, 30.5 and 30.7 mg respectively. P-coumaric acid content was 32, 30.9 and 30.3 mg, but contents of ferulic acid in meals was 150, 150.4 and 151.6 mg, respectively. Total antioxidants content were 263.5, 262.5 and 262.7 mg, respectively, it was observed that all prepared diet has antioxidant content including quercetin, caffeic acid, p-coumaric acid and ferulic acid.

The chemical composition for prepared meals was shown at**Table (6).** The energy content for the three prepared diets was ranged between 1174 to 748 Kcal, respectively. Protein content reached 21.2 to 13.4 g, respectively. The three prepared diets provide fat from 29.8 to 24.4 g, carbohydrates from 205 to 115g. Calcium content from 192.5 149 mg while phosphorus provide 430 to 336mg. magnesium 146-99mg, iron 7.3-6.64 mg, zinc 3.14-2.8, vitamin A 1572-460 µg, Vitamin C provide 128-67 mg.

Eating problems for children before and after tested diets rich in some antioxidants were recorded in **Table (7).** The underweight children were recorded 44.50% but after tested diets this percentage decreased to 37%. There was a slight improvement in the percentage of children who suffer from obesity 14.80% before tested diets compared to 11.10% after tested diets. Loss of appetite and constipation problems were 11.10%

and 3.70% these percentage lowered to 3.75% and zero%. There was no change in abdominal pain, parasites and diarrhea before and after diet intervention.

Table (4): Sensory evaluation of prepared diets for children with weakness memory.

Parameters / Diets	Appearance (score =10)	Texture (score =20)	color (score =10)	Taste (score =20)	Odor (score =20)	Moisture (score=20)	Pore (score=20)	Flavor (score=20)	General acceptability
Vanilla biscuits with yellow cornmeal	9.7±0.73	19.6±0.79	9.7±0.68	19.6±0.76	----	19.6±0.80	----	19.6±0.76	97.8±0.92
Chocolate Peanut Butter Biscuits	9.1±0.88	18.75±1.03	9.5±0.67	18.4±1.21	----	19.2±0.96	----	18.6±1.03	93.5±0.62
Fruit cake with beet jelly	9.52±0.81	19.5±0.1.01	9.7±0.55	19.6±0.84	19.6±0.65	----	----	19.4±1.19	97.3±0.81
Fruit cake with cocoa jelly	9.6±0.52	19.25±0.95	9.6±0.57	18.6±0.90	18.9±0.81	----	----	19.5±0.81	95.5±0.65
Chocolate cupcake with yellow cornmeal	9.2±0.88	19.3±0.94	9.4±0.67	19.4±0.87	19.6±0.83	----	18.1±135	----	95±0.88

Data are expressed as means± SD.

Table (5): Antioxidants contents in prepared diets

Items	Serving size (gm)	Quercetin (mg)	Caffeic acid (mg)	P-Coumaric acid (mg)	Ferulic acid (mg)	Total Antioxidants (mg)
Meal (1): Vanilla biscuits with yellow cornmeal + Fruit cake with cocoa jelly	692	50	31.5	32	150	263.5
Meal (2): Chocolate cupcake with yellow cornmeal + Fruit cake with red beet roots jelly	678	50.7	30.5	30.9	150.4	262.5
Meal (3): Chocolate peanut butter biscuits+ Vegetables salad	447	50.1	30.7	30.3	151.6	262.7

Table (6): Chemical composition for prepared diets.

Items	Energy (Kal)	Protein (g)	Fats (g)	Carb. (g)	Ca (mg)	P (mg)	Mg (mg)	Fe (mg)	Zn (mg)	V.A (µg)	V.C (mg)
Meal (1):	1174	21.2	29.8	205	149	430	99.5	6.64	3	842	84.3
Meal (2):	986	13.4	25.8	175	167.5	405	146	6.73	3.14	460	128
Meal (3):	748	17	24.4	115	192.5	336	99	7.3	2.8	1572	67

Table (7): Nutritional problems for children with weakness memory.

Test / Eating problems	Before		After	
	N	%	N	%
Underweight	12	44.50%	10	37%
Obesity	4	14.80%	3	11.10%
Loss of appetite	3	11.10%	1	3.75
Constipation	1	3.70%	Zero	Zero
Abdominal pain	3	11.10%	3	11.10%
Parasites	2	7.40%	2	7.40%
Diarrhea	1	3.70%	1	3.70%

Table (8): Behavioral problems for children with weakness memory.

Test / Problems	Before		After	
	N	%	N	%
Memory impairment	27	100	5	18.51
Inattention	27	100	6	22.22
Hyperactivity	19	70.30	10	37
Sleep disorder	15	55.50	10	37
Anger	23	85.10	19	70.30
Violence	20	74	13	48.10
Impulsive	16	59.20	12	44.44

Table (9): nutrients intake for children with weakness memory

Nutrients	Before (%)	After (%)	Sig
Protein	85.11±2.53	106.18±6.08	0.000**
Carb.	70.44±4.34	105.11±6.47	0.000**
Fat	85.11±2.53	106.18±6.08	0.000**
Energy	73.14±3.58	103.81±4.38	0.000**
Calcium	69.44±9.90	86.29±8.05	0.000**
Phosphorus	71.81±9.72	90.00±6.71	0.000**
Iron	73.77±12.17	106.96±10.73	0.000**
Zinc	65.18±14.44	101.74±8.26	0.000**
Mg	62.00±14.56	103.37±5.54	0.000**
Vitamin A	102.00±10.30	238.07±10.65	0.000**
Vitamin C	105.40±8.76	301.29±28.52	0.000**
Vitamin E	81.51±12.62	100.88±10.53	0.000**
Folate	65.22±14.97	72.18±12.80	0.000**

Table (8) revealed behavioral problems for children. Memory impairment, inattention, and hyperactivity before diets intervention were recorded 100%, 100%, and 70.30% but after supplemented tested diets were decreased to 18.51%, 22.22%, and 37%, respectively. Sleep disorder before supplemented diets were 55.5% and lowered after tested diets to 37%. Before tested diets behavioral problems anger, violence, aggressiveness, and impulsive were recorded 85.10%,74%,33.30% and 59.20% respectively, while these levels were lowered after tested diets supplementation to 70.30%,48.10%, 18.51% and 44.44%, respectively. It was clear that prevalence of behavioral problems was very high such as (memory, attention, violence, hyperactivity, impulsive and sleep disorder). However, these problems were lowered after diets intervention.

The percent of nutrients intake of the 24 hour recall were showed in **Table (9).** The results revealed highly significant increase ($p \leq 0.01$) in protein, carbohydrate, fat, energy (85.11±2.53, 70.44±4.34, 85.11±2.53 and 73.14±3.58 %) before diet intervention compared after diet intervention VS (106.18±6.08, 105.11±6.47, 106.18±6.08 and 103.81±4.38%), respectively. Also, the results revealed a high significant increase in minerals intake for (Calcium, phosphorus, iron, zinc and magnesium) before diet intervention (69.44±9.90, 71.81±9.72, 73.77±12.17, 65.18±14.44 and 62.00±14.56) % compared after diet intervention Vs (86.29±8.05, 90.00±6.71, 106.96±10.73, 101.74±8.26 and 103.37±5.54)%, respectively. In addition (vitamin A, vitamin c, vitamin E and folate) before diet intervention were recoded (102.00±10.30, 105.40±8.76, 81.51±12.62 and

65.22±14.97) compared after intervention (238.07±10.65, 301.29±28.52, 100.88±10.53 and 72.18±12.80) % , respectively.

The data present in in **Table (10)** show children's water drinking percent before and after tested diets, data showed that the highest percentage of drinking water one liter per day was 62.90% before tested diets but this percentage decreased after tested diets was 33.30%. The percentage of drinking water two liter per day after tested diets improved and become the highest percentage 40.70% compared with before tested diets 26%. Children who drink 3 liter of water per day before tested diets was 11.10% compared with after tested diets was 26%.

Table (10): Water drinking percent for children with weakness memory.

Test / Quantity	Before		After	
	N	%	N	%
One liter	17	62.90%	9	33.30%
Two liter	7	26.00%	11	40.70%
3 liter	3	11.10%	7	26%

Discussion

Healthy eating and active lifestyles are associated with children's healthy weight and memory development. This study examines the effectiveness of administration diets rich in some natural antioxidants to improve the abilities of memory and nutritional status for primary school children with learning disabilities.

Children suffering from weakness memory enjoyed with meditate IQ with (Stanford Penney) **(Table 1).Siquara et al., (2018)** reported that working memory is a good predictor of academic achievement specifically, (reading, spelling and mathematics) than IQ.

Many studies showed that quercetin injection affected the antioxidant defense system and improved STZ-induced memory impairment **(Molaei et al., 2020).** Moreover, **Toshiyuki et al., (2016)** indicated that memory recall was enhanced in aged mice fed a quercetin-containing diet. Memory recall in early-stage Alzheimer disease patients, was significantly improved by the intake of quercetin-rich onion (Quer gold) powder for 4 weeks. In recent study by **(Saenno et al., 2022)** suggested that caffeic acid attenuated the impairment of memory in D-gal-stimulated aging by up-regulating levels of hippocampal neurogenesis and **(Deshmukh et al., 2016)** suggested that CA administration ameliorated learning and memory function via increases in synaptic protein expression and antioxidant functions to protect against oxidative stress induced neuronal cell damage.

Moreover, **(Kima et al., 2017)** demonstrated that the treatment of p-coumaric acid improved avoidance memory and long-term retention of spatial memory in behavioral tests. Another study confirmed that p-CA improves AlCl3-induced passive avoidance memory decline p-CA also alleviated depression-related memory impairment **(Rashnoab et al., 2022).** Also, **(Luo et al., 2012)** showed that ferulic acid could alleviate learning and memory deficits of vascular dementia. FA inhibits d-gal-induced Acetyl cholinesterase activity, oxidative stress, neuro inflammation and neuro degeneration, and consequently ameliorates memory impairment **(Yang et al., 2016).** The above mentioned studies are with the line with the obtained results.

The obtained results showed that children with normal weight, low weight, or overweight suffer from weakness memory as shown in **(Table3).DeRodrigues et al., (2006)** showed that schoolchildren born with very low birth weights exhibited increased risk of learning disabilities (memory weakness, Intention and cognition weakness) when compared with those born at full term.

Ling-Teo and Jiar-Yeo, (2017) revealed that there is relation between working memory and behavioral problems. Internalizing behavioral problems played critical roles in affecting the scores of Malay language (writing) at school this problemsincluding verbal short-term memory, inattention, somatic complaints, visuospatial working memory and aggression. Attention-deficit/hyperactivity disorder (ADHD) is a neurobiological condition of childhood onset with the hallmarks of inattention, impulsivity, and hyperactivity. Hyperactivity includes an excessive rate of speech and motor activity. Complications of ADHD include academic failure, low self-esteem, poor work performance, substance abuse, criminal justice issues and social problems **(Castejón et al., 2019).Castejón et al., (2019)** observed that patients with sleep disorders which suggest an alteration of memory consolidation process during sleep. Many ADHD patients have cognitive dysfunction and sleep problems, including longer sleep latency, lower sleep efficiency, and shorter total sleep time **(Lee et al., 2014),** these results

were harmony with the results at **table (8).**

A stronger inverse association between increased intake of higher-fiber, lower-Glycemic Load vegetables and weight change, consistent with experimental evidence suggesting an influence of these factors on satiety, glucose and insulin responses, fat storage, and energy expenditure **(Bertoia et al., 2015).** Ferulic Acid could be beneficial in lowering the risk of High Fat Diet -induced obesity via modulation of enzymatic, hormonal and inflammatory responses **(De Melo et al., 2017).Erejuwa et al., (2017)** suggested that 1.0 g of honey/ kg BW of rats produced beneficial effects on obese rats, while high doses of honey (2 or 3 g of honey /kg BW) did not increase BMI and it can be suggested that honey has a potential to serve as a viable functional food or a substitute for artificial/synthetic sweeteners in obese diets. These results are matched with the obtained results at **table (9)** that indicated a significant increase of carbohydrate, fat, protein intake, while the BMI didn't change due to diets intervention.

Severe dehydration has been shown to cause cognitive deficits such as short-term memory and visual perceptual abilities as well as mood disturbance, whereas water consumption can improve cognitive performance, particularly visual attention and mood **(Masento et al., 2014).** The percent of drink water was improved after diet intervention as shown in **table (10).**

Conclusion

Finally, it could be concluded that dietary intervention rich in diets rich in polyphenols could improve and enhance memory status in children with learning disabilities.

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