GLYCEMIC INDEX OF CHOCOLATE FORTIFIED WITH PUMPKIN (*CUCURBITA MOSHATA*) AND TARO (*COLOCASIA ESCULENTA*) POWDER AND ITS EFFECT ON MOOD AND COGNITIVE FUNCTIONS OF FEMALE STUDENTS

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ABSTRACT

This study aimed to determine Glycemic Index of chocolate fortified with pumpkin and taro powder and observed its effect on mood and cognitive functions of UniSZA female students. Two groups of female students (n = 30) were asked to consume control chocolate (Group A) and fortified chocolate (Group B) for four weeks. Their mood and cognitive functions were observed in mean of three replications. Their 2-hours postprandial blood sugars were assessed by finger-prick blood to determine their Glycemic index value. The results showed an increased in mean value of 5-points mood scale in both groups from not at all happy to moderately happy after 15 minutes of its consumption. Meanwhile, respondents in group B scored higher mean value in memorizing 10 listed items and gave a steady rise in their blood sugar and insulin levels compared with group A.

Keywords: fortified chocolate; pumpkin; taro; glycemic index; cognitive function; mood.

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1. INTRODUCTION

Chocolate confectionaries form a great part of the sweet's market and produce diverse products. However, certain food products especially confectionaries have negative reputation

due to the high content of calories what is the main reason for obesity and diverse health issues. Concerning this fact, market should provide more products with additional nutritional value which is good taste and also ensure good functional properties. In this study, fortification of pumpkin and taro powder into chocolate is an effective way to overcome deficiency beside give a lot of beneficial health to human due to it higher mineral and vitamin content.

Pumpkin is an excellent source of provitamin A carotenoid because it is believe to contains high amount of carotenoid such as α-carotene and β-carotene. Yellow-orange colour of pumpkin would distinguish it is presence of carotenoid [1]. Many previous studies reported that carotenoid can enhance the immune response and reduce the risk degenerative disease such as cancer and cardiovascular diseases due to its ability to quench singlet oxygen and react with free radicals found in human body [2]. Furthermore, taro is widely produced throughout the world and easy for the availability of the raw material used. Taro roots contain a wealth of organic compounds, minerals and vitamins that are essential for human health [3]. Besides, high level of fiber in taro root makes it very important for digestive health [4]. Fiber will help to prevent certain condition such as excess gas, bloating and constipation. Hence, addition of these two local crops into chocolate is an effective way for human consumption to obtain a healthy good diet. Chocolate also has been prove by the scientist can enhance human mood after it consumption [5]. Both the flavanols and methylxanthines in the chocolate are believed to play a role in human's mood enhancing effects. Besides, flavanol in the chocolate can accumulate in the brain regions involved in learning and memory. Flavanols will increase blood flow to brain, promote formation of new neurons and improve the functioning of neurons [6].

Chocolate also can be classified as low Glycemic Index food and consumption of it has been associated can decreased risk of cardiovascular disease, type 2 diabetes, metabolic syndrome and depression [7]. Low GI foods, can slow the digestion and absorption, produce gradual rises in blood sugar and insulin levels, and have been proven benefits to health. Meanwhile, foods with a high GI are those which are rapidly digested and absorbed and result in marked fluctuations in blood sugar level [8]. GI is a type of measurement on how quickly foods

breakdown into sugar in bloodstream and determine how they affect glycemia (blood sugar level) after meals [9].

Studies that support a link between chocolate and good health are very popular with readers. However, the reality is that the most chocolate studies are observationally in nature and therefore limited in what they can tell us about its supposed benefits. At present moment, there are limited number of fortified products with underutilized crops such as pumpkin and taro tubers. Hence, fortification of the chocolate with these crops is an effective strategy to prevent or overcome deficiency. Apart of it, it is an excellent approach to diversify functional foods by using local crops. In this study, glycemic Index of chocolate fortified with pumpkin and taro powder was determined and the effect of fortified chocolate consumption on mood and cognitive function among UniSZA female students were observed.

2. RESULTS AND DISCUSSION

2.1. Demographic Data

Demographic data include age, weight, height, BMI status, highest education, CGPA result and marital status. Demographic profile was developed to study respondent's background with more details. Table 1 showed demographic profile of respondents between the groups.

Table 1. Demographic data between group A and group B

Choices	Group A		Group B	
	N = 30	%	N = 30	%
Age				
Below 21	3	10	5	16.67
22-25	24	80	24	80
Above 25	3	10	1	3.33
Weight (kg)				
Below 45	2	6.67	3	10
45-60	15	50	17	56.67
Above 60	13	43.44	10	33.33
Height (cm)				

Below 140	5	16.67	2	6.67
141-160	19	63.33	19	63.33
Above 160	6	20	9	30
BMI status				
Underweight	5	16.67	2	6.67
Normal	16	53.33	19	63.33
Overweight	7	23.33	8	26.67
Obesity	2	6.67	1	3.33
Highest education				
High school	-	-	-	-
Diploma	2	6.67	3	10
Degree	28	93.33	27	90
CGPA result				
First class honours	8	26.67	11	36.67
Upper class honours	18	60	16	53.33
Lower class honours	2	6.67	2	6.67
Third class honours	2	6.67	1	3.33
Marital status				
Single	29	96.67	30	100
Married	1	3.33	-	-

From the data, it showed that the majorities of the respondents were in range of age 22 to 25 years old with the value 80% (n = 24) for both groups. While, 10% (n = 3) of them from group A fall in the range of age below 21 and above 23 years old. In group B, only 1 person age above 25 with the value 3.33% and the remaining were16.67% (n = 5) age below 21 years old.

Most of the respondents also have weight between 45 to 60 kg with value 50% (n = 15) for group A and 56.675 (n = 17) for group B. The data also indicate that only 2 persons from group A and 3 persons from group B have weight below 45 kg with the value 6.67% and 10%.

More than 10 person from both groups fall within the range of weight above 60 kg with value 43.33% (n = 13) and 33.33% (n = 10). Besides, 63.33% (n = 19) of the respondents from both groups have height of 141 to 160 cm. Only 6.67% (n = 2) and 16.67% (n = 5) respondents have height that below 140 cm for both groups. Another 20% (n = 60) and 30% (n = 9) female students have height above 160 in group A and B.

From demographic question, it showed that most BMI status for both groups of the respondents fall in the range of normal with value 53.33% (n = 16) and 63.335 (n = 19). A normal BMI was in the range of 18.5 and 24.9 [10]. However, there were some of the respondents that had BMI underweight may be because lack of nutritious food intake. From data, 5 persons from group A and 2 persons from group B indicate underweight with value 16.67% and 6.67%. It also showed that 23.33% (n = 7) from group A have overweight and 26.67% (n = 8) from group B also overweight in their BMI value. Overweight may cause from the unhealthy food pattern like consume too much cholesterol food. Small number of respondents were obesity, which were 2 persons from group A and 1 person from group B with value of 6.67% and 3.33%. Risk factors to get obesity are lifestyle, high intake of energy-dense, micronutrient-poor foods, sugar soft drinks and fruits juices and adverse social and economic condition [11].

Overall form the data, it showed that most of the female students currently have their degree level as their highest education with value 93.33% (n=28) for group A and 90% (n = 27) for group B. Meanwhile, only 6.67% (n = 2) and 10% (n = 3) from both groups of respondents have diploma as their highest education. Demographic data also include their current Cumulative Grade Point Average (CGPA) result in their study because it was one of the factors to observe their cognitive development. Generally, accepted that a person education improves the cognitive performance and it can be evaluated in term of IQ, achievement and academic success as measured by grade, special education and high school graduation [12].

From the data, it showed that most of the respondents fall in the range of upper class honours with value 60% (n = 18) for group A and 55.33% (n = 16) in group B. While, 6.675 (n = 2) from group A have CGPA fall in the lower and third class honours. It also indicate that 8 person from group A have grade of first class honours with value 26.67%. Students who get

their pointer above 3.67 can be classified in first class honours. While in group B, it shows that only 1 person fall in the third class honours with 3.33% and another 2 persons are lower class honours with 6.67%. The remaining of the respondents in group B, 36.67% (n = 11) classified as first class honours. From the study, only 1 respondent in group A has the status married with value 3.33% and the remaining 96.67% (n = 29) are single. While in group B, all the respondents are status single.

2.2. Nutrition and Health Data

Poor eating habit like under or over-eating, not having enough of healthy food or consuming too many types of food and drink with high calories content can affect the nutrient intake including energy, protein, carbohydrates, essential fatty acid, vitamin, mineral as well as fiber. In this study, respondent's health history was determined by Nutrition and health questionnaires.

Table 2 shows the Nutrition and health data for both groups. From result of medical history, it showed that 4 respondents which 3 of them from group A with value of 10% and 1 from group B, 3.3% have migraine. While, another 6.67% (n = 2) from group A and 10% (n = 3) group B suffer from gastric. From these values, it showed that some of the respondents had consumed migraine and gastric intake in their daily life. In both groups, 83.33% (n = 25) and 86.67% (n = 23) of them have good health status because they free from diseases and medicine intake in their daily life.

From the medical history, 16.67% (n = 50) and 13.33% (n = 4) from both group have food allergies. They have allergic with seafood, peanuts and also wheat. While, the remaining of the respondents which were 83.33% (n = 25) and 86.67% (n = 26) were free from food allergic reaction. From the questionnaire, half of the respondents also had consumed supplements in their daily life. Types of supplements they consume were vitamin C, collagen drink and habbastu sauda. In group A, 13.33% (n = 4) of them consume vitamin c and 23.33% (n = 7) collagen drink. While, in group B, 10% (n = 3) of respondents take vitamin c supplement and 16.67% (n = 5) take collagen drink and another 2 person 6.67% take habbatus sauda as their supplement.

Normally, a person can get all the nutrients from a balanced diet. However, taking

supplements can provide additional nutrients when she lack in diet or have certain health condition that may cause insufficiency or deficiency. Vitamin C supplement will function as antioxidants and it was important for preventing oxidative damage to cellular and sub cellular cell structure [13]. However, majorities of the respondents from both groups were not consume supplement intake in their daily days with value 63.33% (n = 19) in group A and 66.675 (n = 20) in group B.

In this study, the stress history was also determined and the results showed 66.67% (n = 20) and 73.33% (n = 20) respondents in both groups sometime feel stress in their daily life. While, another 16.67% (n = 5) from group A feel stress moderately and very often in their daily life. Besides, in group B, only 26.67% (n = 8) persons which were 4 of them feel stress very often and another 4 feel stress moderately in their daily life. Stress problems are very common among college students and this is because of the busy schedules crammed with work, study and extracurricular activities. A healthy diet can help to defense against stress and some foods in particular offer stress-bursting qualities. Consumption of 49 g dark and milk chocolate daily was an effective way to reduce perceived stress in female [14]. Besides, the data also indicate that 100% (n = 30) from both groups were not suffer from bipolar disorder.

Food intake was one of the factors that will determine someone's health. From the data, it showed how many times a day respondents eat and the majorities which were 73.33% (n = 22) and 83.33% (n = 25) of them eat 3 times a day which were breakfast, lunch and dinner. From both groups, only 2 persons from each respondent 6.67% eat 4 times a day. Furthermore, 20% (n = 6) from group A and 10% (n = 3) group B were only eat 2 times a day. From the value, we can summarized that they were not having a good food pattern because they might skip their breakfast or maybe their dinner.

Respondents from both groups also consume caffeinated drink in their daily for example coffee, tea, chocolate and soft drink. In group A, it showed that half of the respondents consume caffeinated drink with value 50% (n = 25). While, the remaining respondents in group A were not consumed caffeinated drink in their daily. The data also informed us that 56.67% (n = 17) respondents from group A love to drink caffeinated beverages, while another 43.33% (n = 13) of them were not. Adults who consume low-to-moderate amount of caffeine

have improved exercise endurance, cognition, reaction time and mood with sleep deprivation [15].

From the data physical activity history, majorities of them were not physically active with the value 66.67% (n = 20) and 60% (n = 18) from both groups. Besides, the remaining of them 33.33% (n = 10) and 40% (n = 12) from both groups were currently physically active. Most of them which 16.67% (n = 5) from each group do exercise daily like playing badminton, netball, volleyball, jogging and cycling and the activities listed are take time about more than 30 minutes per day. Besides, some of respondents with values 16.67% (n = 5) and 23.33% (n = 7) from both groups do workout like zumba every noon and this activities take about 10 to 30 minutes per day. Physical activity has been linked to mental health benefits for a variety of psychological outcomes belong to three main dimensions which are self-perception, emotional and cognitive functioning [16].

Table 2. Nutrition and health data for both groups

Choices	Group A		Group B	
	N = 30	%	N = 30	%
Medical history				
Medicine intake				
Migraine	3	10	1	3.33
Gastric	2	6.67	3	10
No	25	83.33	26	86.67
Food allergies				
Yes	5	16.67	4	13.33
No	25	83.33	26	86.67
Supplement intake				
Vitamin c	4	13.33	3	10
Collagen drink	7	23.33	5	16.67
Habbatus sauda	1	3.33	2	6.67
No	18	60	20	66.67
Stress history				

How often you feel stress daily				
Very often	5	16.67	4	13.33
Moderately	5	16.67	4	13.33
Sometimes	20	66.67	22	73.33
Suffer from bipolar disorder				
Yes	-	-	-	-
No	30	100	30	100
Nutrition history				
How many times a day you eat				
1	-	-	-	-
2	6	20	3	10
3	22	73.33	25	73.33
4	2	6.67	2	6.67
Consume any caffeinated drink				
Yes	15	50	19	63.33
No	15	50	11	36.67
Physical activity history				
Currently physically active				
Yes	10	33.33	12	40
No	20	66.67	18	60
How long per session				
Below 10 min per day	5	16.67	2	6.67
10-30 min per day	3	10	7	23.33
More than 30 min per day	2	6.67	3	10

2.3. Effect of Chocolate Consumption on Mood

Mood of the respondents were examined throughout four weeks. The data was presented in total mean score value of three replications. Mean score values were calculated and

represented scale from 1 (not at all) to 5 (extremely much). Table 3 showed the respondents mood effect after consumption of control and fortified chocolate.

From the results, it showed a change in respondent's mood after 15 minutes consuming control chocolate by an increase of happy mood mean score from 1.86 (not at all) to 2.85 (slightly). Besides, after 15 minutes consumption of control chocolate, it showed again an increase in happy mood of respondents from 2.82 (slightly) to 3.23 (moderately). Meanwhile, for the fortified chocolate, the results clearly showed that after 5 minutes of it consumption, mood of the respondents increased from 1.81 (not at all) to 2.51 (slightly) happy. Then, after 15 minutes of the consumption, it again rise the mean score of their happy mode from slightly to moderately happy. For both chocolate samples, during 15 minutes to 90 minutes of its consumption, most of the respondent mood remain moderately happy.

Throughout the minutes for both samples, sad feeling of the respondent was also declined from moderately sad (3.27, 3.29) before the chocolates consumption to not at all (1.34, 1.57) after 15 minutes of the consumption. Besides, some respondents also have neutral feeling and mood which is they did not know which mood they are in. They cannot differentiate either sad or happy. However, before consumption of these chocolates, it showed that most of respondents from both samples have moderately (3.03, 3.06) neutral mood. However, after 15 minutes of chocolates consuming, the neutral mood decline to not at all (1.51, 1.27).

Carbohydrates food including chocolate have a comforting effect and also promote good feel sensation through the release of multiple gut and brain peptides [5]. But, the true explanation for why chocolate makes people happy is chemical in nature. There are over 300 naturally occurring chemicals in chocolate and some of them may affect human brain. People who eat chocolate will release several neutrotransmitters that have positive effect in human feeling. One of these is phenylethlyamine which causes alertness and a degree of excitement, quickens the pulse rate and makes you happy [5]. Another neurotransmitter was serotonin that will regulates mood and create a good feeling. Serotonin also had been called as an anti-depression agent. There were many roles of serotonin include influence over sleep, appetite, impulse control and mood elevation [17].

Furthermore, the respondents were also surveyed about their stress and nutrition history. From

the data of Nutrition and health, it showed that most of the students from both groups only feel stress sometimes in their daily life. Besides, their eating habits also were surveyed and there was a significant positive correlation between their eating habit and mood effect. From the data, it showed that most of the students from group B eat 3 times per day and it was the ideal number for an individual. However, the number of meals we eat per day depends on the energy we need and also the schedule. Hormone also was another parameter that will affect mood of human. When someone is under stress, her adrenal glands will produce cartisol, which is stress hormone. When the level of cartisol is high, it will block estrogen and ended up less estrogen getting into cell and it will cause less produce of serotonin [18].

Besides, estrogen hormone was important in mood effect because it has the ability to increase serotonin and beta-endorphins which are associated with positive mood states [19]. However, during a female's menstrual cycle, level of estrogen hormones release was very low. Low levels of estrogen and progesterone signal the pituitary gland to produce Follicle Stimulating Hormone (FSH). FSH begins the process of maturing a follicle which was fluid-filled sac in the ovary containing an egg. Hence, this was the reason why female in their menstrual cycle has negative mood effect and sometimes decline in their cognitive function [20]. However, the mood test was conducted only in a few number of respondents who in menstruation state. The rest of the respondents were in fertile state, which meant in the state where they had passed the period. At this state, level of estrogen hormone was high and it may cause high released of serotonin that later on will create happy mood to them. Table 4 showed the number of respondents who in menstruation infertile, fertile (non period) and infertile (in PMS state) over the four weeks of mood test.

Table 3. Mean score of mood at difference time points after consumption of test foods

Samples	Mood	Minutes					
		0	5	15	30	60	90
Control	Happy	1.4	1.86	2.82	3.23	3.18	3
	Sad	3.27	2.23	1.34	1.31	1.21	1.1
	Neutral	3.03	2.4	1.51	1.13	1.38	1.15
Fortified	Happy	1.81	2.5	3.38	3.38	3.47	3.3

Sad	3.29	2.51	1.57	1.59	1.21	1.1
Neutral	3.06	2.38	1.27	1.43	1.12	1.48

*values in the column showed total mean score of 5-point mood scales,*1-1.9 = not at all, *2-2.9 = slightly, *3-3.9 = moderately, *4-4.9 = very much, *5-5.9 = extremely much

Table 4. Period history of respondents in both groups over the four weeks of mood test

Choices	Group A		Group B	
	N = 30	%	N = 30	%
Period history				
Week 1				
Menstrual infertile	6	20	7	23.33
Fertile	12	40	9	30
Infertile	12	40	14	46.67
Week 2				
Menstrual infertile	5	16.67	6	20
Fertile	14	46.67	15	50
Infertile	11	36.67	9	30
Week 3				
Menstrual infertile	8	26.67	4	13.33
Fertile	12	40	13	43.33
Infertile	10	33.33	13	43.33
Week 4				
Menstrual infertile	7	23.33	6	20
Fertile	12	40	9	30
Infertile	11	36.67	15	50

2.4. Effect of Chocolate Consumption on Cognitive Function

Cognitive data of the respondent was determined before and after 30 minutes of chocolate consumption. The data was expressed in percentage mean value of the score for three replications. Fig. 1 and 2 showed the cognitive data before and after 30 minutes chocolate consumption of the respondents from both groups. Five trials were conducted in this method

in order to test the memory learning of the respondents. Cognitive is the scientific study of the mind as an information processor. Cognitive can be tested in perception, attention, language, memory, thinking and consciousness. From the overall result, it showed that an increase in the percentage mean score of item in each trial for both groups. This was happened because regular intake of cocoa flavanols may have a beneficial effect on cognitive function and possibly protect against normal age related to cognitive decline [21]. In control group, the result showed that respondents able to memorize 52.5% of the score list items at trial 5. It shows an increase in the total score as compared at trial 1, they only able to memorize 22.5% out of 100%. However, in the fortified group, the result showed a bit increase in the respondents' memory test. At trial 5, they able to memorize 55% as compared at trial 1 they only can memorize 27.5%.

From the result in Fig. 2 which was after 30 minutes of the chocolate consumption, it also clearly showed an increased in the total percentage mean score of list item the respondents able to memorize in each trials. For control group, the respondents able to memorize up to 90% score of items at trial 5 as compared during trial 1. They only can memorize only 45% score of items. However, respondents who consume fortified chocolate showed a higher score, which is 95% at trial 5. As refer to the previous nutrition and health data, respondents who consume fortified chocolate (group B) have high number of students who consume caffeinated drink. In addition to cocoa flavonols, other psychoactive components of chocolate include the methylxanthines, caffeine and theobromine, both of which have been associated with improving alertness and cognitive function [17].

However, there were many factors that determine the progress of the cognitive development. Some of the factors were biological factor, hereditary factor and nutritional factor. The students were surveyed with these factors and there showed a positive correlation between the cognitive function with these factors. Scientists have proven that genetics play a major role in cognitive development [22]. Children actually inherit their intelligence from their parents. In fact, many scientists discovered that it is not possible to control intelligence and cognitive development because these are pre-determined by hereditary factors. Physical activity of the respondents also has positive correlation with the improvement of cognitive. Physical activity

has been linked to mental health benefits for a variety of psychological outcomes belong to three main dimensions which are self-perception, emotional and cognitive functioning [16].
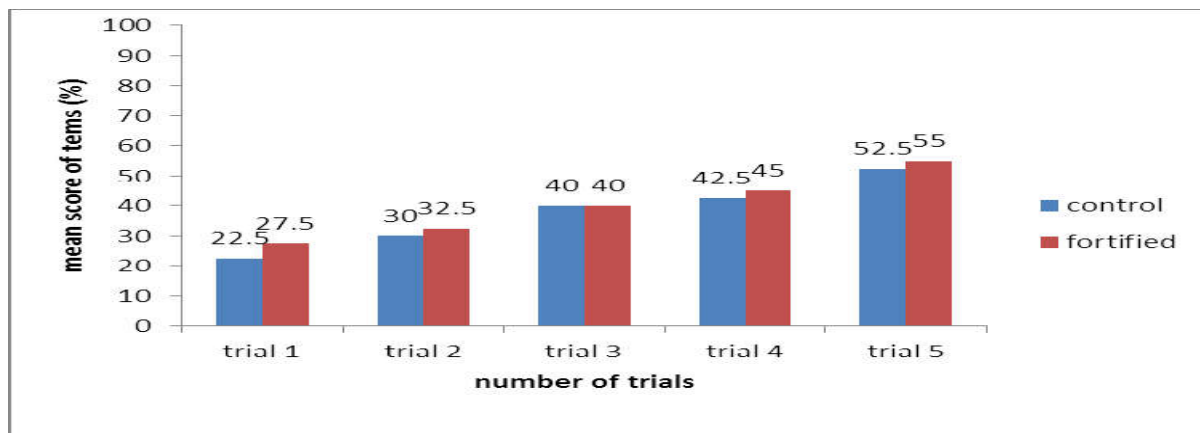

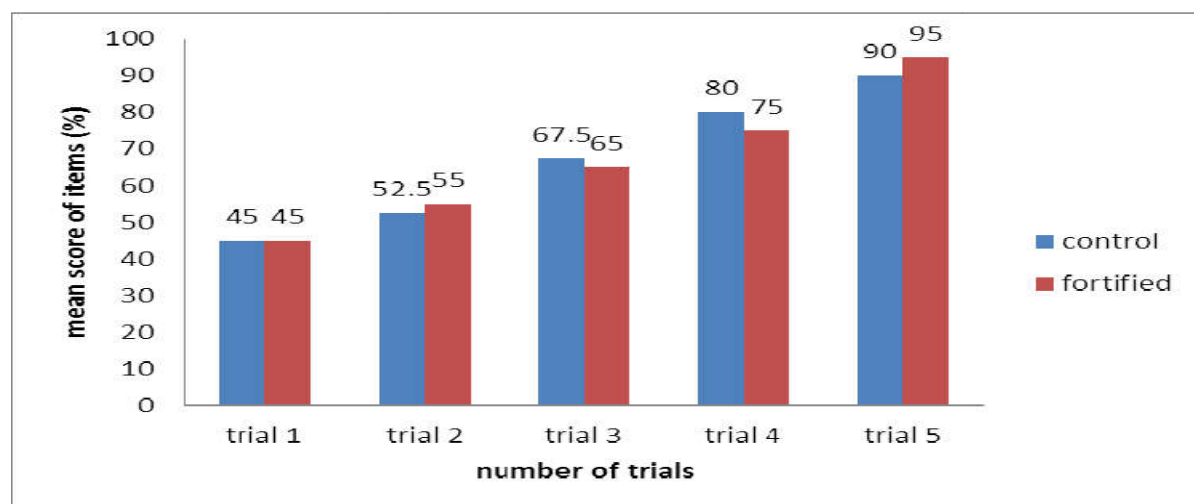**Fig.1.** Cognitive data of respondents before consume the test foods

Fig.2. Cognitive data of respondents after 30 minutes consume the test foods

2.5. Glycemic Index (GI) of Chocolates

GI is a measurement of blood sugar which is glucose levels after meal. Carbohydrates are the main constituent of food that can raise blood sugar levels. Carbohydrates from liquids such as juice and soft drinks are usually digested more rapidly. Carbohydrates from solid foods such as pasta and fruits take a bit more time to break down. In this study, three different groups were asked to consumed three different test foods which were glucose solution, control chocolate and fortified chocolate. Table 5 presented the average GI value measured in 30 subjects of different groups.

In particular, GI value of the control and fortified chocolate group was significantly (p < 0.05) different with glucose group. Glucose is a simple sugar that is easily broken down by the body and transport into body cell for the energy. Consumption of glucose solution give a fluctuation in respondents blood sugar levels because it is easily absorb into bloodstream and cause a dramatically rises in their blood sugar level after 15 min consumption. Blood sugar levels can start increasing after 15 minutes after meals and food with high GI will rise highly due to the type of carbohydrates found in food [23].

The concentration of blood sugar level changes throughout the day based on what we eat and our activity level. Food that have been showed to have a low glycemic responses include whole-grain cereal, paste and also chocolate. It will cause a steady rise in blood glucose and insulin level after its consumption [24]. Based on results, GI values for control and fortified chocolate were rises slowly in every minutes and the peak of the blood sugar reading for both chocolates were at 45 and 60 minutes. This was happened because low GI foods have a modest effect on blood sugar levels and it may take a little bit longer to see a rise [23]. Hence, from results, we can see that blood sugar levels at minutes 30 as compared with minutes 15 and 45 there was no significantly different in time because at that time food is generally absorb into the blood bloodstream after the meals.

A healthy person will have a blood glucose level of 70 to 105 mg/dl in a fasting state equivalent to 3.9 to5.8 mmol/L [25]. A person is considered diabetic if they have a blood glucose level at or above 126 mg/dl (7 mmol/L) in a fasting state [26]. If a person has diabetes, body will not regulate glucose level well because it has problem with insulin. If they consume high content of carbohydrate it will cause high rise of their blood sugar level and may lead to various chronic diseases. Consuming low GI foods is very important because it will avoid fluctuation of blood sugar levels and it also will provide a gradual, continuous supply of energy from one meal to the next.

Furthermore, there were many factors affecting GI of food and some of it were fiber content, protein and fat. Food containing soluble fiber such as oat has a lower effect on the GI because they delay the gastric emptying. In this study, taro has been claimed has high content of fiber and this was one of the reasons fortification chocolate give low rises of blood glucose level to

the respondents [27]. Besides, the presence of protein and fat may lower the GI value. However, it is no advisable to add much more fat in food due to health reasons. Excess proteins tend to increase the body's insulin and fat has effect of decreases the effectiveness of the insulin.

Table 5. Blood glucose level (mmol/L; mean ± standard deviation) at different time points after consumption of the test foods

Sample	Minutes
	0	**15**	**30**	**45**	**60**	**75**	**90**	**120**
	$5.10^{a,B}$	$8.92^{f,B}$	$8.16^{e,f,B}$	$7.15^{e,B}$	$6.37^{d,B}$	$5.7^{c,B}$	$5.14^{b,B}$	$4.86^{a,B}$
Glucose	± 0.43	± 0.64	± 0.67	± 0.5	± 0.45	± 0.41	± 0.31	± 0.21
Control	$5.14^{a,A}$	$5.36^{f,A}$	$5.69^{e,f,A}$	$5.99^{e,A}$	$6.00^{d,A}$	$5.78^{c,A}$	$5.36^{b,A}$	$5.12^{a,A}$
chocolate	± 0.46	± 0.34	± 0.41	± 0.47	± 0.38	± 0.31	± 0.36	± 0.29
Fortified	$5.14^{a,A}$	$5.42^{f,A}$	$5.63^{e,f,A}$	$6.00^{e,A}$	$5.86^{d,A}$	$5.58^{c,A}$	$5.3^{b,A}$	$5.07^{a,A}$
chocolate	± 0.47	± 0.43	±0.39	± 0.38	± 0.53	± 0.73	± 0.58	± 0.45

Note: Values in the same column with difference alphabet are statistically significant from each other ($p < 0.05$), *alphabets A, B, C represented samples, *alphabets a, b, c, d, e, f represented minutes. Presented data was mean value ± standard deviation.

3. EXPERIMENTAL

3.1. Materials

Two different chocolate flavours, white chocolate and dark chocolate brand Beryl's were purchased at supermarket in Terengganu. The Glycemic Index (GI) of the students was measured using a glucometer that was assessed by finger-prick blood samples. The portion of chocolate was 35 grams equivalent to one small bar for both the control and fortified chocolate as the test foods. Others materials used in this study including pumpkin and taro powder that was obtained from the various laboratories in the Faculty of Bioresources and Food Industry, University Sultan Zainal Abidin.

3.2. Methods

3.2.1 Preparation of Control and Fortified Chocolate

The chocolates were chopped into small pieces and 200 grams of each chocolate were weight. Then, white and dark chocolates were melted in the tempered machine separately at temperature 35°C. After melted, 1 gram of pumpkin powder was added into white chocolate compound and another 1 gram of taro powder was added into dark chocolate compound. The chocolates were stirred continuously at constant temperature until mixed. For the fortified chocolate sample, 1.2 ml of white chocolate mixed with pumpkin powder was filled into the mould bar and kept in chiller for 10 minutes. White chocolate will acts as coating. After 10 minutes, another 2.5 ml of extra dark chocolate mixed with taro powder was filled into the same mould bar and allowed the chocolate to cool in chiller for another 10 minutes. After cool, filled another same 1.2 ml of white chocolate into the same mould bar and kept it chill for 10 minutes. The same procedures were conducted for the control sample by excluding pumpkin and taro powder.

3.2.2. Subjects

Sixty female students (n = 60) age between 20 to 26 years old were took part in this study. Subjects were recruited from Universiti Sultan Zainal Abidin, Faculty of Bioresources and Food Industry. Subjects who have been reported medically restricted diet or any kind of ongoing illness were excluded in this test.

3.2.3. Selection of subjects

In this study, all the subjects were divided into two groups. Group A (n = 30) will consume 35 grams of control chocolate. While, another Group B (n = 30) will consume 35 grams of chocolate fortified with pumpkin and taro powder for 4 weeks in order to determine their Glycemic value, mood and cognitive function. Subjects were selected based on Nutrition and Health Questionnaire.

3.3. Design and procedure

3.3.1. Glycemic Index test

This study was conducted as described by [28] with slightly modifications. A rounded drop of blood was taken from three groups. The first group consist of 30 subjects who drink glucose (16 g of glucose in 100 ml of water equivalent to 16 g of available carbohydrates in 35 g of chocolate bar), next group consist of 30 subjects who eat 35 gram of control chocolate and

another group were 30 subjects who eat 35 gram of fortified chocolate. Immediately, before (0 min) and after 15, 30, 45, 60, 75, 90 and 120 minutes of the consumption, their 2-hours postprandial blood sugar (2HPP) were assessed by finger-prick blood for all groups (mmol/L).

3.3.2. Consumption of Chocolate and Its Effect on Mood

This study was conducted as described by [29] with slightly modifications. The subjects were consumed 35 g of test foods and the effect was examined every four weeks. On the first week, the mood was evaluated before and after they consume the test foods. Same procedures were conducted for the four consecutive weeks where they need to complete the 5-scale mood questionnaire before consume and every 5, 30, 60 and 90 min after the consumption. The result of their 5-scale mood was presented in term of mean score for three replications.

3.3.3. Consumption of Chocolate and Its Effect on Cognitive Function

This study was conducted as described by [30] with slightly modifications. One simple method for clinical use was conducted in this study to evaluate the memory learning of the respondents. The method presented here was allowed the respondents to show that they have learned something by evaluating their memory test. The result was analyzed in terms of their mean scored in each trials.

Based on the method, the subjects were asked to learn a list of words by verbal recall in any order. The entire lists were read aloud once to the respondents at a 2-second rate before her first recall attempt. The subjects then need to recall back all words listed in any order. The test was conducted before and after 30 minutes of the chocolate consumption in order to evaluate their memory test on 10 listed items. All respondents have five trials in each test. They need to memorize 10 listed items and their mean scored of item they successfully memorized were calculated in three replications.

3.4. Statistical analysis

The experiment set was used to compare the Glycemic Index, mood and cognitive test between group A and group B. Mood result was represented in term of mean score of the 5-mood scale using the formula. While, cognitive test also represented in the total mean score (%) of the items a respondent able to memorize. Glycemic index's result between three groups was expressed in term of mean ± standard deviation. Two way analysis of variance (ANOVA)

was performed in this test to determine the level of significance which the confidence level was set at $p < 0.05$ and the data was compared using Duncan's test at $\alpha = 0.05$. The data analysis was pursued by using statistic software which was SPSS.

4. CONCLUSION

Pumpkin and taro were underutilized local crops which can be incorporated into foodstuff. Addition of these ingredients into chocolate was an effective way in producing a healthy snack meal thus significantly increase mood, cognitive performance and also reduce fluctuation of blood sugar level. Product made in this study with addition of pumpkin and taro powder had increase positive mood of the respondents after the consumption. Besides, the result also showed that cognitive performances of the respondents who consume fortified chocolate increased in term of their memory test. Hence, fortification of chocolate with these two local crops can be a good food source for students who suffer from stress that can lead to poor cognitive function. This study also focus on the Glycemic Index of chocolate fortified with pumpkin and taro powder and from the result, the addition of these two local crops have more favourable effect on glucose metabolism. Consumption of this product showed a steady rise in blood sugar and insulin levels. Thus, this fortified chocolate has good benefits to human health and has a big potential to be commercialized as functional food.

5. ACKNOWLEDGEMENTS

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