

Research Article

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Bioactive peptide effect on brain activity identified by 2D brain mapping

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Abstract: Soybean is a grain product that has a lot of protein content. Bioactive peptides derived from soybean protein are believed to have the ability to maintain brain health such as the neurotransmitter system. Brain mapping is a mapping of the electrical activity of the brain to study the functional human brain. In this study, 2D brain mapping based on power spectrum is proposed to see the differences in brain activity in adolescents before and 1 h after consuming soy peptide using the 19-channel electroencephalogram. In the experiment, the adolescents in an age range of 16–24 years were involved (fasting in the span of 7–8 h before the experiment). The 2D brain mapping results showed that after consuming soy peptide, the subject as seen from alpha waves experienced an increase in activity by 5%.

Keywords: EEG, brain wave, methadone, stimuli

1 Introduction

One of the structures and neurotransmitters in the nerve cell connections in the brain is formed by amino acids. Asparagine is an α -amino acid that is used in the biosynthesis of proteins. The brain and nervous system are parts of the human body that have the most complex and sensitive physiological structures. As a result, humans are required to have a healthy balanced diet and adequate intake of all nutrients for the development of a

healthy nervous system starting from before birth and also maintaining neuronal and nerve tissues throughout the life. In previous studies, it was found that amino acids in the form of tryptophan, tyrosine, histidine, and arginine obtained from protein foods are indispensable for the brain nervous system for the synthesis of various neurotransmitters and neuromodulators (Betz et al. 1994). Meanwhile, in other studies, it is explained that the peripheral concentration of certain amino acids can play a role in the regulation of central nervous transmission, cognitive performance, and mood (Hartmann 1986). Other researchers state that the administration of tryptophan can cause drowsiness and reduce pain sensitivity in humans (Young 1996). These changes are in line with several serotonin-related functions in the central nervous system. Other components such as glutamic acid are needed to maintain and boost the immune system while aspartic acid helps in the performance of brain neurotransmitters (Ohinata et al. 2007; Hirata et al. 2007; Hou et al. 2011). High-quality sources of amino acids are animal protein, such as beef, chicken, eggs, and dairy products (Yang et al. 2018; Noroozlo et al. 2019). Soy peptides obtained from soybeans are a food source that can produce high-quality amino acids that are almost the same as those of an animal protein. Neurologist explains the ingredients in tempeh (food made from fermented soybean seeds) can shield or protect the brain and cognitive functions, so that it can prevent Alzheimer's dementia caused by brain function damage. Fermentation of soy results in food containing lots of bacillus that are good for the brain (Yimit et al. 2012). Low-quality amino acids can be obtained from other plants such as vegetables, jelly and fruit but can only perform their basic functions in a shorter time. Although research related to foods that affect the brain was done before, systematic discussions regarding the role of soy peptide in changes in brain activity have not been widely studied (Kanegawa et al. 2010; Oda et al. 2012; Mizushige et al. 2013; Yamamoto et al. 2015; Ota et al. 2017).

Sanchez and Vazquez (2017) explains that the combination of amino acids with covalent bonds is enabled by an organic substance that forms bioactive peptides known

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as amide or peptide bonds. These bioactive peptides play a crucial role in the working of the digestive, endocrine, cardiovascular, immune, and nervous systems. The chief role of bioactive peptides in the human body is drawing the interest of researchers and practitioners, especially in the food sector, to explore the development of new food additives and peptide-based functional products as done in this study. Bioactive peptides have been considered as a new generation of biologically active regulators that have preventive functions such as oxidation and microbial degradation in food (Moldes *et al.* 2017; Lemes *et al.* 2016).

Research about the bioactive peptides using bio-signals is still very rare. In the literature study conducted, the only biosignal-based research was done to study the effect of soy peptides on immune function, brain function, and neurochemistry in healthy volunteer participants whose data were processed using fNIRS (Yimit *et al.* 2012). Our previous works had been using the electroencephalography (EEG) system (Turnip *et al.* 2019). EEG possesses several electrode sensors connected to a data acquisition system and is used to measure brain activity through the surface of the scalp. Brain topography mapping from EEG is a promising new method in neuropsychiatry and neuropsychopharmacology. Rapid advances in computer technology enabled online analysis using microcomputers. This article describes the system of signal acquisition and analysis to study the neurophysiological and neuropsychopharmacological aspects of the functioning of the human brain. The brain is the center of the nervous system and consists of millions of laden cells or neurons that regulate and coordinate most of the body's homeostatic movements, behaviors, and functions such as heart rate, blood pressure, body fluid balance, and temperature. Neurons are carriers of information in the form of representations of human body activity with the brain. In addition to the various ways, the brain cognitive behavior can be understood by analyzing the changes in signal patterns or images of the brain. By using the EEG signals and their characteristics, various activities of the human body will be identified. In previous studies, the EEGs are used for drug detection (Turnip *et al.* 2017; Iskandar *et al.* 2019), controlling wheelchair (Turnip and Hong 2012; Turnip *et al.* 2015), and other application (Simbolon *et al.* 2019).

Brain mapping is mapping of the electrical activity of the brain to study the functional human brain. In this study, the role of peptides in brain activity was evaluated using EEG. The results of the EEG signal recording are then processed and evaluated through a 2D brain mapping pattern viewed from the color of brain waves based on the frequency.

2 Methods

This study was conducted in Universitas Padjajaran in collaboration with Laboratorium of Cogno-Technology, Indonesian Institute of Sciences, Indonesia. Seventeen male healthy volunteers of age ± 22 years participated in the experiment (Turnip *et al.* 2019). The study participant selection criterion is that they must almost be of the same age, assuming they have a similar metabolic system, which is processing peptides and delivering them to the brain in almost the same time. Two conditions for the experiment are close eyes while relaxing before and after consuming soy peptide. Each condition is recorded for 5 min. All subjects involved in the experiment provided written informed consent and they were also provided remuneration for transport.

In the experiment using the EEG system, the pattern of electrode placement greatly affects the quality of the recorded brain signal data. If the electrodes are incorrectly in contact with the scalp and if the electrodes are unstable, then the recorded data tends to be contaminated with artifacts or disturbances due to the movement of the participants. To better ensure the contact of the electrodes with the surface of the scalp, each electrode is injected with an electro gel which increases the conductivity. The EEG system used in the experiment has 31 channels; but according to research, only 19 channels (Fp1, Fp2, F7, F3, Fz, F4, F8, T3, C3, Cz, C4, T4, T5, P3, Pz, P4, T6, O1, and O2) were used (Turnip *et al.* 2019). When injecting the electro gel, the conductivity level of the electrodes with the scalp can be directly monitored on a computer screen. Good conductivity will produce a green color in WinEEG applications (brighter colors indicate better conductivity and *vice versa*). If a dark color still exists when installing the electrodes, then electro gel is added or the position of the electrodes are adjusted by slightly moving the electrode. Apart from conductivity, the size and shape of each participant's head can also affect the quality of the EEG data recorded, which can be overcome by selecting the appropriate electro-cap size. The electro-cap used in this experiment was moderate. Therefore, if the head size of the subjects involved is too large or too small, it will greatly affect the quality of the recorded signal. The EEG Mitsar 202 system (31 channels) with electro gel installation display screen is shown in Figure 1. The experimental design was prepared to identify the change pattern in brain signals before and 1 h after consuming soy peptide.

Several processes are involved before extracting the features from the EEG recording data. First, in the EEG recording process the electrode placement pattern and

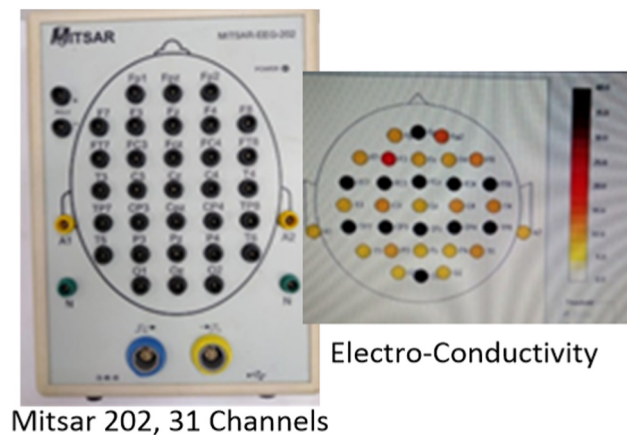


Figure 1: EEG instrument for experiment.

the recording device specifications can also affect the credibility of the recorded data to be used. The placement of electrodes at the time of recording generally follows the existing system, namely, the 10–20 system which can be seen in Figure 1. Of the 19 selected channels, each channel was adjusted to four locations of the brain regions, namely, frontal (F), parietal (P), occipital (O), and temporal (T). As shown in Figure 1, the odd number codes indicate the left side and the even numbers indicate the right side of the brain. Figure 2 demonstrates the experimental setting of the effects of soy peptides on brain wave activity in closed eye conditions, and the data processing scheme is given in Figure 3.

The EEG recorded signal is highly dependent on various factors of the participants, such as mental health,



Figure 2: Experiment setup of the soy peptide effect on brain wave activity in open eye condition.

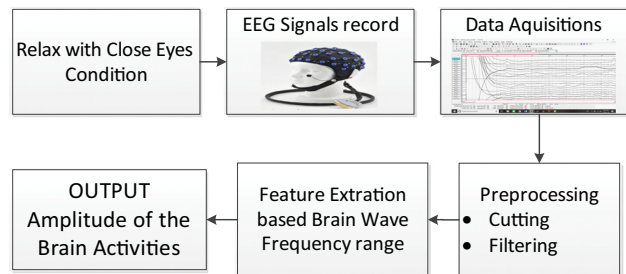


Figure 3: Experiment and processing scheme.

activity, environment, other organ dysfunction, external stimuli, and the age of the subject. The EEG recorded signals are distinguished by frequency range and are classified into five waves, namely, delta, theta, alpha, beta, and gamma waves. The results of the EEG signal recording are then processed and evaluated through a 2D brain mapping pattern. Using the soybean data that has been processed using brain mapping in 2D form viewed in terms of the color of brain waves based on the frequency (delta = dark blue, theta = light blue, alpha = green, beta1 = yellow, beta2 = red, and gamma = maroon red) and average. The average power spectrum for closed eyes relax before and after consuming soy peptide was calculated for each subject to see the difference. Power spectrum is the strength or more precisely the energy of the signal at each frequency.

3 Results and discussions

After carrying out the EEG data recording experiment to study the changes in brain signal activity, the interference or artifact was filtered (using a band-pass filter with a cutoff frequency of 0.5–70 Hz) and the signal cutting method was performed. It was observed that the signals are highly contaminated by some artifacts and difficult to recognize. In the feature extraction process, raw data were manually cut based on the amount of the obtained data from the records and the desired information as stated in the research objectives. The obtained feature is an average amplitude extracted from the cutting data results. More details of the extracted amplitude can be seen in Tables 1–3. Tables 1 and 2 (subject 1) show the change in the mean brainwave amplitude of each channel in two recording sessions: 1 h before and after consuming soy peptides. The recording scenarios in the experiment used in this article are relaxed and blindfolded. Since the subject was blindfolded, delta and gamma waves were not discussed in detail in this study. This is because it

Table 1: Pre: Amplitude of each channel of subject 1

Channels	Delta		Theta		Alpha		Beta 1		Beta 2		Gamma	
	%	Hz	%	Hz	%	Hz	%	Hz	%	Hz	%	Hz
Fp2-F8	36.54	1.46	10.12	4.15	8.77	7.57	2.43	16.36	3.77	24.17	2.93	30.27
F8-T4	24.46	1.46	8.36	3.91	17.02	10.99	4.6	17.82	7.79	22.95	6.49	30.52
T4-T6	16.12	1.71	6.25	4.39	40.84	10.99	4.15	17.58	6.32	22.95	3.81	32.23
T6-O2	15.83	1.46	9.5	4.15	47.2	10.99	3.57	13.92	4.78	21.73	2.23	30.76
Fp1-F7	30	1.46	9.64	4.15	10.13	7.32	2.66	14.16	3.19	20.02	2.09	30.03
F7-T3	22.32	1.46	7.4	4.15	17.86	10.99	3.66	19.29	5.94	23.68	4.48	29.79
T3-T5	10.39	1.46	4.71	4.15	44.21	10.99	4.66	19.78	9.63	22.46	6.95	38.09
T5-O1	13.41	1.71	7.89	4.15	54.39	10.99	3.61	13.92	5.74	29.79	2.86	29.79
Fp2-F4	42.27	1.46	9.5	4.15	7.59	7.57	2.19	17.58	2.72	20.02	1.6	30.03
F4-C4	28.07	1.46	12.78	3.91	22.26	10.99	3.72	13.92	4.29	21.73	1.98	30.27
C4-P4	19.16	1.46	7.69	3.91	43.78	10.99	3.31	13.92	3.89	22.22	1.34	30.03
P4-O2	21.02	1.46	9.27	4.15	38.79	10.99	3.54	14.4	5.43	21.73	1.77	30.76
Fp1-F3	36.22	2.2	10.51	3.91	9.32	12.45	2.67	14.16	3.24	20.02	1.83	29.79
F3-C3	26.17	1.46	11.09	3.91	29.29	12.45	3.45	13.92	4.51	21.24	1.62	30.03
C3-P3	15.47	1.46	6.98	3.91	53.94	10.99	3.13	13.92	5.01	21.73	1.4	29.79
P3-O1	14.06	1.46	7.83	5.13	54.51	10.99	3.77	13.92	6.1	21.73	1.77	29.79
Fz-Cz	24.71	1.46	12.42	5.62	28.5	12.45	3.81	13.92	4.41	23.44	1.9	30.27
Cz-Pz	24.61	1.46	9.5	3.91	31.75	10.99	3.19	13.92	3.41	21.24	1.32	31.01
Average	23.38	1.53	8.97	4.21	31.12	10.65	3.45	15.36	5.01	22.38	2.69	30.74

is assumed that the majority of activities that occur on both waves are due to noise or artifact interference. Tables 1 and 2 (subject 1) show the change in brain wave amplitude values for each pair of channels for each range frequency. It can be seen individually that the average

amplitude of each wave tends to increase (except delta waves) before and after consuming soy peptide, indicating an increase in brain activity or an increase in blood flow to the brain. The difference in each average amplitude is marked in bold in Tables 1 and 2.

Table 2: Pre (after 1 h): Amplitude of each channel of subject 1

Channels	Delta		Theta		Alpha		Beta 1		Beta 2		Gamma	
	%	Hz	%	Hz	%	Hz	%	Hz	%	Hz	%	Hz
Fp2-F8	32.81	1.46	8.61	3.91	7.02	7.32	2.1	13.92	3.39	24.41	2.67	32.47
F8-T4	24.32	1.46	9.77	3.91	17.8	11.47	4.36	13.92	6.88	22.46	5.52	30.76
T4-T6	18.97	1.46	6.79	3.91	39.08	11.47	3.06	14.16	4.39	22.22	2.2	31.25
T6-O2	20.03	1.46	8.73	4.88	40.05	11.47	3.53	13.92	4.18	22.46	1.87	31.01
Fp1-F7	32.2	1.46	10.27	3.91	10.94	7.32	3.28	13.92	3.76	21.48	2.38	31.49
F7-T3	24.91	1.46	10.69	3.91	19.23	11.47	4.5	19.78	7.14	19.78	4.66	30.03
T3-T5	10.16	1.46	5.16	4.15	51.81	11.47	4.48	18.31	8.21	22.46	4.7	39.06
T5-O1	9.97	1.46	7.2	3.91	61.16	11.47	3.58	13.92	5.08	22.71	2.51	30.27
Fp2-F4	36.7	1.46	11.4	3.91	9.52	7.32	3	15.63	4.06	20.51	2.65	32.47
F4-C4	25.79	1.46	14.18	5.37	27.74	11.47	5.25	13.92	5.76	20.51	2.62	29.79
C4-P4	17.35	1.46	9.05	3.91	48.72	11.47	4.12	13.92	4.75	22.46	1.76	31.01
P4-O2	15.46	1.46	9.48	3.91	49.42	11.47	4.23	13.92	6	22.46	2.09	31.01
Fp1-F3	36.8	1.46	11.27	3.91	9.35	7.32	3.11	14.65	3.73	21	2.08	29.79
F3-C3	23.41	1.46	13.34	6.1	31.57	11.96	4.61	13.92	5.73	20.51	2.42	30.27
C3-P3	14.76	1.46	7.18	3.91	54.28	11.47	3.74	13.92	5.36	23.19	1.66	30.27
P3-O1	10.81	1.46	7.41	6.35	60.02	11.47	3.76	14.16	5.29	21.73	1.73	30.27
Fz-Cz	22.97	1.46	13.16	6.1	24.38	11.96	4.06	13.92	4.84	19.78	2.68	30.03
Cz-Pz	15.24	1.46	9.54	5.62	52	11.47	4.44	13.92	5.13	20.51	1.97	31.49
Average	21.81	1.46	9.62	4.53	34.12	10.60	3.85	14.65	5.20	21.70	2.68	31.26

Table 3: Pre: Amplitude of each channel of each brain wave

Subjects	Before						After 5 min						After 1 h					
	δ	θ	α	$\beta 1$	$\beta 2$	γ	δ	θ	α	$\beta 1$	$\beta 2$	γ	δ	θ	α	$\beta 1$	$\beta 2$	γ
S1	23.4	9.0	31.1	3.5	5.0	2.7	16.2	7.4	31.0	9.9	8.2	6.0	21.8	9.6	34.1	3.9	5.2	2.9
S2	23.5	8.1	14.7	3.3	4.4	2.4	16.4	7.1	19.9	5.5	9.9	9.4	17.8	4.9	11.8	2.7	4.2	2.8
S3	18.2	7.1	33.7	3.7	4.4	1.8	20.3	6.0	27.0	2.8	3.2	0.6	17.1	8.3	32.8	4.7	5.5	2.7
S4	17.5	12.9	37.1	4.7	3.8	2.1	17.8	11.4	48.1	4.1	3.1	1.6	16.5	12.0	45.0	3.7	2.4	1.3
S5	14.5	8.7	34.6	7.9	5.8	4.4	13.1	8.6	24.2	5.2	7.6	1.8	14.4	8.7	11.7	7.1	7.4	7.8
S6	17.4	5.9	46.3	4.2	5.5	2.2	12.3	4.4	42.3	3.2	4.7	1.9	10.2	5.6	54.8	5.6	8.5	4.0
S7	19.5	7.0	29.1	3.8	5.0	3.2	17.3	6.4	35.4	4.2	5.8	3.9	14.4	9.6	36.5	4.3	5.7	3.3
S8	13.5	7.7	44.6	4.7	6.8	3.9	15.1	7.6	39.2	7.2	7.6	4.9	13.6	8.3	45.3	6.6	6.3	3.4
S9	10.6	7.2	63.8	4.4	3.6	1.9	10.7	7.4	62.1	3.7	3.1	1.7	10.2	5.5	57.3	3.8	3.3	2.0
S10	14.7	13.7	55.8	3.3	2.5	1.4	15.5	13.6	51.6	3.4	3.2	2.0	13.6	14.4	57.2	3.3	2.4	1.2
S11	15.6	8.0	24.5	3.4	5.4	4.2	23.4	9.0	31.1	3.5	5.0	2.7	21.8	9.6	34.1	3.8	5.2	2.7
S12	16.1	6.0	42.6	5.6	5.7	3.0	16.4	7.2	42.6	6.2	6.3	3.8	15.6	9.2	29.1	4.5	4.7	2.9
S13	14.6	9.1	35.7	4.4	7.8	3.7	12.0	6.4	23.0	2.3	2.7	1.9	13.7	7.7	28.8	3.8	6.6	1.7
S14	10.6	7.1	25.7	3.4	7.1	1.7	14.0	5.4	24.0	3.3	5.7	2.9	15.7	8.9	36.0	7.1	9.3	6.1
S15	18.2	13.6	34.0	4.7	6.2	4.3	17.3	12.2	38.3	4.7	6.1	4.4	14.0	9.8	39.9	5.3	6.8	5.6
S16	14.1	5.5	22.6	3.6	3.7	2.0	10.4	4.2	3.0	2.2	2.3	1.8	8.8	9.8	45.9	4.3	8.5	7.3
S17	21.7	9.2	31.9	3.6	3.8	3.6	2.6	7.4	25.1	2.3	2.1	2.0	18.3	9.1	36.6	3.5	3.1	3.3
Average	16.7	8.6	35.8	4.3	5.1	2.9	14.7	7.7	33.4	4.3	5.1	3.2	15.1	8.9	37.5	4.6	5.6	3.6

The electrode position in the experiment was based on a bipolar montage pattern in which the sensors seem to be connected from front to back and from left to right in a straight line format. The research objective was to observe changes in brain wave activity based on frequency, highest activity based on location, maximum amplitude, and reactivity. Based on frequency, alpha (normally between 8 and 13 Hz) is the most prominent wave among other brain waves. The central frequency of alpha waves was thought to be closely related to the amount of blood flow to the brain and this variation can change up to 2 Hz between subjects depending on the amount and velocity of blood flow. Tables 1 and 2 show the variation in changes in amplitude and frequency on each channel and each wave. From the results in Tables 1 and 2, it can be clearly seen that all the central frequencies in the bipolar derivation except FP1-F3 and Fz-Cz are found to be increased. This reactive or responsive value is also related to mental activity and eye movements. However, since the subjects involved in the experiment were relaxed and closed their eyes, the increase was strongly suspected as a result of consuming soy peptides.

The condition of eye movement plays a major role in the alpha rhythm changes. Apart from eye movements, alpha rhythm which is an individual rhythm is also greatly influenced by a person's level of concentration. If the concentration is higher, the alpha rhythm will tend to decrease. Therefore, alpha-dominant rhythm is usually obtained when the subject is awake, resting, and eyes are

closed (fits the experimental scenario used in this study). An increase in the average middle frequency of the alpha waves which is thought to indicate an increase in blood flow to the brain is considered sufficient evidence that soy peptide with its protein content plays a role in increasing the brain activity.

Table 3 compares the average brain wave amplitude: pre (before soy peptide), pre (5 min after soy peptide consumption), and after 1 h of soy peptide consumption in all subjects. Table values show that the average maximum amplitude of each brain wave, except the delta waves, tends to increase before and after consuming soy peptides. As previously explained, the delta wave is normally contaminated by artifact from eyes and due to body movement or environment condition. Individually, more than 70% subject shows an increase in the average maximum amplitude. Based on the maximum amplitude, alpha waves have higher amplitude compared to others, which is more than 33 μ V. This result is in line with the fact that alpha waves represent the most pronounced brain activity. The increase in the brain waves (except delta) theta, alpha, beta 1, beta 2, and gamma are 3.5, 5, 7, 9.8 and 24.1%, respectively. Especially for alpha waves, it actually has a bigger amplitude increase without subjects 2 and 5. Both subjects demonstrated very low amplitude (strange) 1 h after consuming soy peptide. It is suspected that both subjects either lacked concentration or did not follow the experiment scenarios while recording the data. For each wave, the average maximum

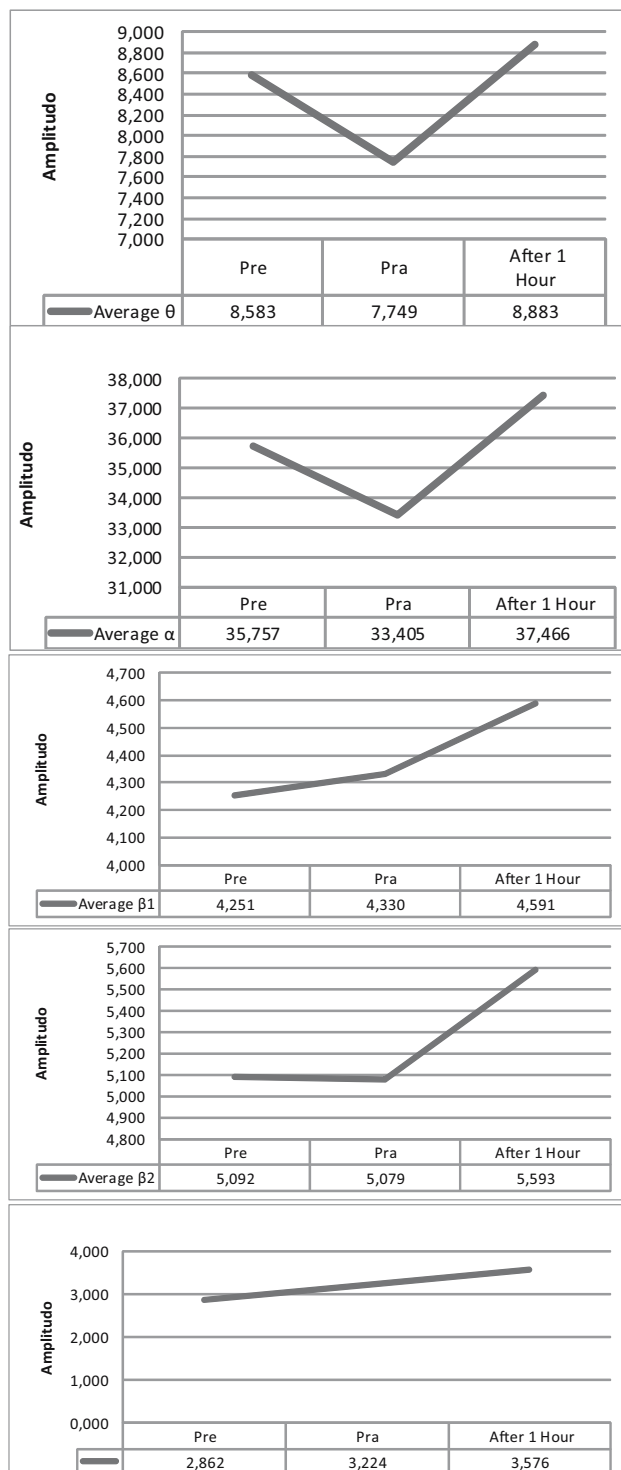


Figure 4: The average increase in maximum amplitude of each wave for subjects before and after consuming soy peptide.

amplitude increase in all subjects can be seen in Figure 4. From the average results it can be seen that the highest average wave was achieved by the alpha waves while the lowest average was obtained by the gamma waves. The highest difference in waves for two conditions was found

in the alpha waves and the lowest average wave was found in the beta 1 waves (closed eye condition).

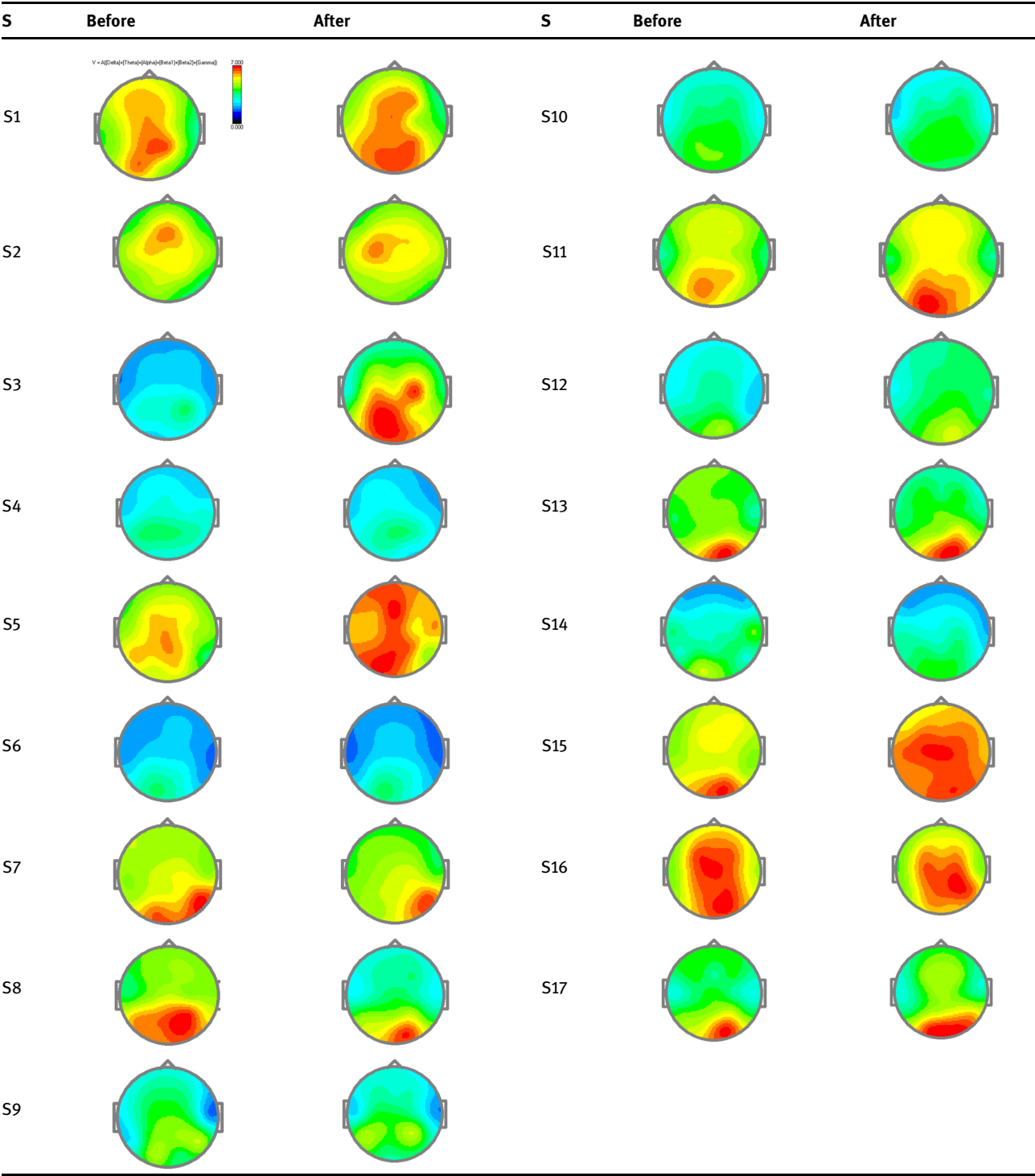
Quantitative EEG (QEEG) is a digital EEG analysis, which in layman's terms is sometimes also called as a brain mapping. The QEEG is often seen as the development of an analysis of EEG interpretation that can be used to help visually understand signal characteristics as well as improve understanding of brain function (Kececi and Degirmenci 2008). This mapping can be understood as a higher form of neuroimaging to produce brain images that are supplemented by the results of additional data processing or analysis. The EEG and QEEG data information are then used to evaluate brain activity and to detect the changes in the brain function due to the treatment given such as consuming soy peptides.

Nerve cells in the brain usually communicate with each other through chemical messengers which are often referred to as neurotransmitters (formed from protein-derived amino acids; Ludwig and Stern 2015). Every meal consumed will affect the nerve chemicals in the brain. Consuming protein can increase the levels of amino acids such as tyrosine which encourages the brain to produce norepinephrine and dopamine in the brain (Gomez-Pinilla 2008). Serotonin, norepinephrine, and dopamine can keep the body energized by increasing alertness and activity. Soy peptide is a source of protein, so its consumption provides more energy to the user, one of which is marked by increased brain activity.

As a result, QEEG metrics in the form of absolute or relative power can be given z scores and represented in a 2D brain map (Table 4). Brain maps compare the absolute power before and after consuming soy peptide. The color scale represents the z score in the range $[-3, 3]$. Thus, excess activity is represented in red (z score > 2) and lack of activity in blue (z score < -2). As seen in Table 4, only one subject has a z score < -2 which is subject 6. From the location of the increased brain region, it appeared that the most dominant occipital parts experienced a more dominant increase in all subjects. When the condition is relaxed and the eyes are closed, a subject will usually experience activity in the absence of rhythm (8–12 Hz) in the occipital section. This condition is consistent with the findings in the previous section, where the activity of the alpha is more dominant, but with QEEG the location of the activity can be known. In the frontal lobe, alpha waves are involved in momentary memory storage and also in cognitive processes. From Table 4, it can also be found that some subjects have increased brain activity in the frontal section.

In Table 4, the blue, light blue, green, yellow, red, and dark red colors indicate the composition of delta,

Table 4: Brain mapping of all subjects in conditions 1 hour before and after consuming soy peptide (S indicates subject)



theta, alpha, beta 1, beta 2, and gamma waves, respectively. From brain mapping, the blue and yellow indicate delta and alpha waves, which appear to dominate the color composition. This is consistent with the data in Table 1 where both waves have the highest average

maximum amplitude. Individually the decrease in brain activity only occurred in subjects 8 and 16, meaning that the brain mapping showed an increase in activity of about 88.2%. The predominance of delta (S3, S4, S6, S9, and S14) and gamma (S5, S15, and S16) waves in

some subjects was impacted by low- and high-frequency artifacts, respectively. Increasing processing capability is expected to reduce the effect of the interference. The ideal brain mapping for each wave composition before and after consuming soy peptide should not be significantly changes such as indicated in the subjects 1, 2, 4, 7–14, 16, and 17.

4 Conclusions

An experiment involving 17 voluntary and healthy subjects was performed to detect an increase in blood flow to the brain after consuming soy peptides. From the results of the study an increase in the central frequency of the alpha wave of 2 Hz was found. In accordance with the designed experimental scenario, those increase occurred due to the consumption of soy peptides. Brain mapping results showed an increase in brain activity of about 88.2% of 17 subjects after consuming soy peptide. Overall, it can be concluded that consuming soy peptide food has been shown to increase brain wave activity.

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