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Proximate Compositions, Physical and Sensory Characteristics of Mixed Green Tea Leaves with Vegetables Snack

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ABSTRACT

The aim of this study is to develop mixed green tea leaves with vegetables snacks. Proximate compositions, physical and sensory properties of mixed green tea leave with vegetables snack were assessed. The vegetables such as water spinach, spinach and *Kailan* were mixed with green tea leaves separately to produce GWS, GS, and GK, respectively. Commercialized seaweed snack (CS) was used as a control. The proximate composition of mixed green tea leaves with vegetables snack and control were determined using Association of Analytical Chemists (AOAC) method. The physical properties (i.e. water activity and texture profile) of the control and mixed green tea leaves with vegetables snacks were assessed using water activity meter and texture profile analyzer, respectively. Sensory evaluation was evaluated by 40 semi-trained panelists. The ash, crude protein, crude fiber, crude fat as well as calories of mixed green tea leaves with vegetables snacks were significantly (P<0.05) higher than the control. Moisture and carbohydrate of mixed green tea leaves with vegetables snack were significantly (P<0.05) lower than control. Texture profile analysis indicated that mixed green tea leaves with vegetables snack and control were no significant (P>0.05) in terms of fracturability, adhesiveness, gumminess and chewiness. Sensory evaluation results indicated that mixed green tea leaves with vegetables snacks were acceptable by panelists as they received score higher than 4.00. Therefore, the findings from this study showed that mixed green tea leaves with vegetables snacks has potential to be developed into snack which is similar with the seaweed snack.

Keywords: Green Tea Leaves, Vegetables, Proximate Composition, Physical Properties, Sensory Evaluation

INTRODUCTION

Fruits and vegetables are very vital food commodities in all over the world for providing a balance and healthy diet to the human (Yahaya & Mardiyya, 2019). However, fresh fruits and vegetables are categorized as perishable food due to their high moisture content, generally greater than 85 % (FAO, 1995; Zottola, 2003; Lufu et al., 2020). Spoilage and deterioration of vegetables is the major caused of postharvest losses during transport, storage and processing (FAO, 2003). Thus, contributed to the increased of food waste. Vegetables such as water

spinach, spinach and *Kailan* has high moisture content which are 92.47 %, 91.4 % and 92. 55 %, respectively (USDA, 2018). These vegetables can undergo preservation method (i.e. osmotic dehydration, drying, fermentation and etc.) or in cooperation in food products as an alternative to reduce food waste (Adeyeye et a., 2022; Doriya et al., 2022; Saleena et al., 2021) to prolong their shelf life..

Green tea leaves that derived from *Camellia Sinensis* is popular with their beneficial health effects which promoted by the present of polyphenols (catechins) (Musial et al., 2020). This health beneficial effects are the driven force for green tea intake. Mostly, green tea is consumed as beverage in the form of whole tea leaves (brewing) and matcha (powdered green tea). However, Burmese people in Myanmar consume green tea as a salad which known as 'Laphet Thoke' (fermented or pickled tea) (Han & Aye, 2015). Consumption of green tea leaves can provide some essential nutrients such as vitamin A, fiber and protein as they are not diffuse out during brewing tea. Green tea leaves are high in protein and fiber which are 28-41 % and 12.75-17.21 %, respectively (Czernicka et al., 2017; Adnan et al., 2013). Yan (2016) reported that, intake of dietary fiber, aids in bowel health and regulates the digestive system.

Snack is a ready-to-eat product that is predominantly consumed between meals (Bechtel, 2001; Temgire et al., 2021). Many snacks food is produced from animal and plant origin such as jerky and potato chip or seaweed snack. Snack that is produced from plant or animal origin (Bechtel, 2001) with just a simple processing technique (i.e. frying and drying) is purposely to prevent losses and waste of the postharvest (FAO, 2003). This also can fully utilize the raw material. Seaweed is fully utilized by processing it into snack such as Nori. Seaweed is consumed for its nutritional value and health benefits as they have abundance of vitamins, minerals and also high of plant-based protein. However, seaweed can accumulate several toxic elements [i.e. cadmium (Cd) and lead (Pb)] (Ródenas de la Rocha et al., 2009) and contributed to food allergic that cause by contamination with amphipods (Thomas et al., 2018)

Present study was conducted to develop a vegetables-based snack food which is the mixed green tea leaves with vegetables snack, in order to reduce postharvest waste as well as fully utilize green tea leaves and local vegetables such as water spinach, spinach and *Kailan*. Mixed green tea leaves with vegetables snack is developed as an alternative to seaweed-based products that have risk of heavy metal contamination while improving the intake of dietary fiber-rich food. Therefore, this study is carried out to determine the proximate composition, physical and sensory properties of mixed green tea leave with vegetables snack. This vegetables-based snack food is expected to be beneficial to people that allergic to seafood and vegetable-averse.

MATERIALS AND METHODS

Materials

All the ingredients (i.e. green tea loose-leaf, water spinach, spinach, *Kailan*, and konjac glucomannan) were purchased at Giant Hypermarket in Jertih, Terengganu, Malaysia. Commercialized seaweed snack that purchased at Giant Hypermarket was used as control sample. The commercial seaweed snack is composed of 95% seaweed, 2.25% sugar, 0.85% spice (i.e. shiitake, cinnamon, clove, and pepper), 0.64% hydrolyzed plant protein, 0.55% fermented soy sauce, 0.36% flavour enhancer and 0.35% salt.

Methods

Mixed green tea leaves with vegetables snack preparation

The vegetables (i.e. water spinach, spinach and *Kailan*) were washed with water before processing. Green tea leaves were blanched in 80 to 90 °C water for 5 minutes while water spinach, spinach and *Kailan* were steam blanched for 5 minutes. The snacks were prepared according to the formulation shown in Table 1. The seaweed commercial snack was served as a control. All ingredient such as green tea leaves (60%), leafy green vegetable

(40%), 1 % xanthan gum, sugar, salt, and monosodium glutamate were mixed using blender (MX-AC400, Selangor, Malaysia). Konjac glucomannan (2.5%) was prepared by hydrated konjac glucomannan in water (0.5:20). konjac glucomannan was spread on the parchment paper followed by the mixture of mixed green tea leaves with leafy green vegetables. After that, the mixture was rolled into thin film by using pasta maker (MARCATO pastadriver, Italy) together with the parchment paper. Konjac glucomannan was spread on top of the mixture prior to drying using ventilated dryer (Tech-Lab, FSD-380, Selangor, Malaysia) at 55 °C for 3 to 4 hours. Sesame oil was spread on top of the dried snack and then the thin film was cut into pieces (6cm × 3 cm). Lastly, the dried snacks were roasted in baking oven at 130 °C for 5 minutes. The snacks were stored in an airtight container at ambient temperature prior to analysis.

Table 1. The formulation of mixed green tea leaves with vegetable leave.

Ingredients	Type of snack		
	GWS	**GS**	**GK**
Green tea leaves (g)	55.8	55.8	55.8
Vegetable leaves (g)	37.2	37.2	37.2
Sugar (g)	4.0	4.0	4.0
Xanthan gum (g)	1.0	1.0	1.0
Salt (g)	1.0	1.0	1.0
Monosodium Glutamate (g)	1.0	1.0	1.0

GWS, GS and GK represented the snack of green tea leaves with water spinach, green tea leaves with spinach and green tea leaves with *Kailan,* respectively.

Proximate analysis

The proximate compositions of the samples were determined according to the official method as described by AOAC (AOAC, 1995). Oven drying (AOAC Official Method 977.11), dry ashing (AOAC Official Method 923.03), Kjeldahl (AOAC Official Method 955.04), Soxhlet (AOAC Official Method 960.39), and gravimetric methods (AOAC Official Method 991.43) was used to determine moisture, ash, crude protein, crude fat, and crude fiber contents, respectively.

Carbohydrate determination

The carbohydrate was calculated by difference (BeMiller & Low, 1998); carbohydrate = 100 g – (moisture + crude protein + crude fat + ash) g. Result was expressed as gram per hundred grams of dry matter (g/100 g of dry matter).

Calorie determination

The calorie value of the sample was calculated according to Nielsen (1998). The total crude protein, crude fat, and carbohydrate were multiplied by the factor value (for each gram of protein and carbohydrate, 4 kcal of energy is obtained, and 1 g of crude fat provides 9 kcal of energy); Energy = (crude protein × 4) + (carbohydrate × 4) + (crude fat × 9).

Water activity

The a_w of the sample was measured using an Aqualab Series 4 water activity meter (Aqualab dew point water activity meter 4TE, Washington, USA) at 25 °C. Solid pieces of sample (about 0.5 g) were evenly placed on

plastic cells and were allowed to equilibrate within the headspace of the sealed chamber. The reading was then recorded when equilibrium was achieved.

Texture profile analysis

The texture properties (hardness, fracturability, adhesiveness, cohesiveness gumminess and chewiness) were measured using a single arm texture analyser (Model TA.XT Plus, Stable Microsystem, Surrey, UK). A sample size 3 cm × 6 cm was placed centrally beneath the spherical probe to achieve a consistent flat surface. Texture analysis was performed through a penetration test by using 5 kg load cell and a spherical probe P/5S. Instrument parameters were set; pre-test speed of the P/5S was 1.00 mm/s, the test speed was 5.0 mm/s and the post-test speed was 5.0 mm/s. Data were analysed using Texture Expert Version 1.05 (Stable Micro System Ltd, Surrey, UK). All the tests were conducted in triplicates, and the average values were reported.

Sensory evaluation

Sensory evaluation of the snack was conducted by 40 semi-trained panelists from the Faculty of Bioresources and Food Industry, Universiti Sultan Zainal Abidin, Besut, Terengganu, Malaysia. The sensory evaluation was performed at the Sensory laboratory of University Sultan Zainal Abidin (UniSZA). Sensory evaluation was conducted using seven-point hedonic scale as described by Watts et al. (1989). The samples were prepared in identical sample containers, coded with three-digit random number and each sample was represented with a different number. The panelists were asked to evaluate each sample for each sensorial parameter including aroma, stickiness, fracturability, cohesiveness, chewiness and overall acceptability based on their degree of liking (1 = dislike very much; 2 = dislike moderately; 3 = dislike slightly; 4 = neither like nor dislike; 5 = like slightly; 6 = like moderately; 7 = like very much).

Statistical analysis

Statistical analyses were conducted using Statistical Package for the Social Sciences (SPSS) software. All the measurements in the experiments were made in triplications to obtain mean value. The significance of the means was compared through one-way ANOVA and Turkey tests at a significance level of $P<0.05$.

RESULTS AND DISCUSSION

Proximate composition

The proximate composition and water activity of commercial seaweed snack (CS) and mixed green tea leaves with vegetables snack are presented in Table 2. The moisture content of mixed green tea leaves with vegetables snack ranged from 1.39 to 1.66 %, which were significantly ($P<0.05$) lower than the moisture content of CS (4.11 %). This was attributed to the addition of konjac glucomannan (KGM) in the mixed green tea leaves with vegetables snack, as a coating. According to Lie et al. (2017), KGM gel that is processed by microwave heating showed a loss of moisture as the surface of gels are partially wrinkled. Thus, lower moisture content in mixed green tea leaves with vegetables snack which was undergone high temperature treatment during roasting.

The ash content of mixed green tea leaves with vegetables (8.70-10.68 %) were significantly ($P<0.05$) higher than that of CS (5.65 %) (Table 2). Ash content can be an index of mineral contents that present in the food material (Ganogpichayagrai & Suksaard, 2020; Lewu & Kambizi, 2015). Thus, this study indicates that incorporation of leafy green vegetables in food products can provide additional minerals. According to Arasaretnam et al. (2018), predominant elements (i.e. Ca, K, Fe, Na) are found in leafy green vegetables. In addition, Czernicka et al. (2017) reported that dried green tea leaves have high mineral content (i.e. Zn, Mn, Mg, K, and Ca). Therefore, the high ash content of mixed green tea leaves with vegetables was attributed to the mineral content in green tea leaves and vegetables (i.e. water spinach, spinach, and *Kailan*).

Table 2. Proximate composition and water activity of commercial seaweed snack and mixed green tea leaves with vegetables snack.

Composition (%dry basis)	Types of samples			
	CS	**GWS**	**GS**	**GK**
Moisture	4.11^{b} ±0.07	1.39^{a} ±0.27	1.66^{a} ±0.54	1.50^{a} ±0.14
Ash	5.65^{a} ±1.87	8.70^{b} ±0.09	10.03^{b} ±0.37	10.68^{b} ±0.13
Crude protein	15.73^{a} ±0.53	22.50^{b} ±1.27	21.45^{b} ±0.10	24.45^{c} ±0.43
Crude fiber	2.27^{a} ±0.87	13.24^{b} ±0.01	13.91^{b} ±0.37	13.63^{b} ±0.49
Crude fat	1.05^{a} ±0.24	3.54^{b} ±0.90	3.01^{b} ±0.20	3.26^{b} ±0.24
Carbohydrate	72.05^{c} ±0.18	63.86^{b} ±2.05	63.85^{b} ±0.15	60.12^{a} ±0.25
Energy (kcal/100g sample)	362.57^{a} ±0.16	377.39^{b} ±4.94	368.31^{a} ±1.95	367.62^{a} ±0.67
Water Activity	0.38^{a}±0.03	0.43^{a}±0.03	0.46^{a}±0.07	0.36^{a}±0.04

Data are mean±standard deviation (n=3). Values with different superscript letters within a row are significantly different ($p < 0.05$).
CS: commercial seaweed snack (control); GWS: green tea leaves with water spinach; GS: green tea leaves with spinach; GK: green tea leaves with *Kailan*

With the regard of crude protein, mixed green tea leaves with *Kailan* (GK) showed significantly (P<0.05) higher than other snacks which was 24.45 % (Table 2). This was attributed to the high protein content in *Kailan* which is 13 %. Crude protein of mixed green tea leaves with vegetables snack ranged from 22.20-22.45 %, were significantly (p<0.05) higher than commercial seaweed snack (15.73 %). This was due to the high protein content of green tea leaves ranging from 28-41 % (Czernicka et al., 2017). The result of crude protein obtained from the current study showed higher than those reported by Rahman et al. (2013) who reported green tea leaves contain 18.15 % of crude protein. Therefore, the mixed green tea leaves with vegetables snack can be claimed as high protein snack based on the Food Act and Regulation 1983 (Food Act & Regulation 1983, 2021).

Crude fiber content of mixed green tea leaves with vegetables snack (13.24-13.91 %) were significantly (P<0.05) higher than that of control, i.e. CS (2.27 %) (Table 2). This was attributed to the present of green tea's stems during processing of mixed green tea leaves with vegetables snack (Adnan et al., 2013). According to Smiechowska and Dmowski (2006), fiber content (i.e. less than 16.5 %) is associated with the keeping quality of green tea leaves in order to maintain high quality of tea during storage. This high-quality during storage was in accordance with the results obtained in the current study. The current obtained results were in line with the previous study conducted by Adnan et al. (2013), who reported that the crude fiber of raw green tea leaves ranged from 12.75-17.21 %.

The crude fat content of mixed green tea leaves with vegetables snack ranged between 3.01 and 3.54 % were significantly (P<0.05) higher than the commercial seaweed snack (CS) which was 1.05 % (Table 2). This was due to the application of sesame oil to the mixed green tea leaves with vegetables snack. The total carbohydrate content in mixed green tea leaves with vegetables snack ranged from 60.12 to 63.86 % were significantly (P<0.05) lower than that control (CS) which is 70.05 %. Mixed green tea leaves with water spinach (i.e. GWS) snack (377.57 kcal/100g) was significantly (P<0.05) higher than other snacks (i.e. CS, GS, GK) (362.57, 368.31, 367.62 kcal/100g). This was attributed to the high crude protein and crude fat contents of the mixed green tea leaves with vegetables snack.

No significant difference was found on the water activity (a_w), a_w of the commercial seaweed snack and mixed green tea leaves with vegetables snack. All snacks had water activity ranged between 0.36 and 0.46 (Table 2). According to Igo and Schaffner (2021), food products with a water activity of less than 0.7 can inhibit the growth of foodborne pathogens. Thus, the current produced snack can inhibit the growth of microbial proliferation, mould and yeast. Low water activity indicates that the mixed green tea leaves with vegetables snack has longer shelf life during storage.

Textural properties

The result of texture properties of commercial seaweed snack and mixed green tea leaves with vegetables snack are summarized in Table 3. The hardness of mixed green tea leaves and vegetables snack (GWS and GK) (9.59 and 12.12 respectively) were significantly (P<0.05) lower than the GS (22.49). This was attributed to higher fiber content in spinach and green tea. According to Ishak et al. (2022), a greater amount of gum arabic (a fiber material) added in snacks, increased the hardness of the snacks. This is in line with the results obtained in the current study, whereby, high crude fiber content was observed to be mixed green tea leaves with spinach (GS). The hardness of commercial seaweed (34.13) showed higher significant different (P<0.05) than the mixed green tea leaves with vegetables snack (9.59-22.49).

Table 3. Texture properties of commercial seaweed and mixed green tea leaves with vegetables snack.

Texture Profile	Types of samples			
	CS	**GWS**	**GS**	**GK**
Hardness (g)	$34.13^{c}\pm1.89$	$9.59^{a}\pm1.09$	$22.49^{b}\pm0.47$	$12.12^{a}\pm3.82$
Fracturability (g)	$22.48^{ab}\pm7.72$	$12.44^{a}\pm1.40$	$39.34^{b}\pm0.80$	$12.81^{a}\pm3.65$
Cohesiveness	$0.22^{a}\pm0.00$	$0.25^{a}\pm0.04$	$0.39^{b}\pm0.05$	$0.25^{a}\pm0.01$
Adhesiveness (g/s)	$-22.25^{a}\pm3.98$	$-11.59^{b}\pm2.10$	$-23.42^{a}\pm0.18$	$-7.64^{b}\pm0.24$
Gumminess	$7.56^{b}\pm0.50$	$2.33^{a}\pm0.08$	$8.66^{b}\pm1.30$	$3.05^{a}\pm0.90$
Chewiness	$6.64^{b}\pm0.94$	$1.83^{a}\pm0.15$	$4.12^{ab}\pm1.33$	$2.05^{a}\pm0.58$

Data are mean±standard deviation. Values with different superscript letters within a row are significantly different (p < 0.05).

CS: commercial seaweed (control); GWS: green tea leaves with water spinach; GS: green tea leaves with spinach; GK: green tea leaves with *Kailan*

No significant (P>0.05) difference was found between commercial seaweed snack and mixed green tea leaves with vegetables (i.e. GWS and GK) snack on fracturability and cohesiveness. With regard to cohesiveness, mixed green tea leaves with spinach (GS) had significantly (P<0.05) higher cohesiveness values (0.39) than commercial seaweed snack (CS) and mixed green tea leaves with water spinach and *Kailan* respectively (i.e. GWS and GK, respectively) which ranged between 0.22 and 0.25, respectively (Table 3). Cohesiveness referred to the deformation of foodstuff before it breaks (Dahri et al., 2015). Mathematically, it defines as the ratio between the area under the time verses force curve during the second cycle divided by the area during the first cycle (Paredes et al., 2022). This indicates that mixed green tea leaves with spinach (GS) was harder to chew, owing

to its high cohesiveness. The fracturability values of all snacks ranged between 12.44 and 39.34 g which indicated that the snacks were easier to crack and crunchy (Rodríguez-Vidal et al., 2016). According to Gibson and Ashby (1997), snacks that contain some fiber granules affect the structure, as fiber granules did not allow a structure compact or readiness for more linear structure, Thus, favoring a break much easier.

Adhesiveness is the ability of food to adhere to the teeth when chewed (Akifusa & Izumi, 2022; Paula & Conti-Silva, 2014). All snacks showed negative values of adhesiveness which indicated the snacks were very adhesive or very sticky. Commercial seaweed snack and mixed green tea leaves with spinach (GS) snack were significantly (P<0.05) higher than other mixed green tea leaves with vegetables snack (i.e. GWS and GK). Adhesiveness of commercial seaweed snack and mixed green tea leaves with spinach (GS) snack in the range of -22.25 and -23.42 g/s, respectively (Table 3). This was due to the fiber granules present in the structure of snacks which make it chewier, Thus, very adhere to teeth (Lee et al., 2023). In addition, the adhesiveness of the snack might be due to the exposure to air making it less crispy (Francis, 2023). Therefore, increased the adhesiveness of the snacks.

The gumminess of commercial seaweed snack and mixed green tea leaves with spinach (GS) showed no significant (P>0.05) difference but significantly (P<0.05) higher than mixed green tea leaves with vegetables snack (i.e. GWS and GK). The gumminess of commercial seaweed snack and mixed green tea leaves with spinach snack (GS) were 7.56 and 8.66, respectively (Table 3). Gumminess referred to the product hardness and cohesiveness (Chandra & Shamasundar, 2015). The higher gumminess has risen from a higher hardness of the commercial seaweed snack and mixed green tea leaves with spinach (GS) snack which were 34.13 and 22.49 g respectively. The present results were in accordance with the reports by Ho et al. (2022), whereby an increase in hardness value of the product caused an increase in green banana flour-based snack bar gumminess.

Chewiness is the number of chewed necessary to be swallowed (Paredes et al., 2022; Paula & Conti-Silva, 2014). The chewiness of commercial seaweed snack and mixed green tea leaves with spinach (GS) snack has higher degree of chewiness which were 6.64 and 4.12, respectively (Table 3). Chewiness is referred to as the product gumminess and springiness (Chandra & Shamasundar, 2015). The chewiness of foodstuff is directly proportional to the gumminess of the food which in accordance with the result recorded in Table 3. A similar trend was observed for chewiness and gumminess for bakery products as reported by Ganesan et al. (2023).

Sensory evaluation

The sensory evaluation scores for aroma, stickiness, fracturability, cohesiveness, chewiness, and overall acceptability were obtained from semi-trained panelists are shown in Table 4. The mixed green tea leaves with vegetables snack exhibited lower scores for aroma (4.90-5.13) than the control (6.48). This was due to the least ingredients used in making mixed green tea leaves with vegetables snack which has contribution to aroma. Commercial seaweed snacks use more ingredients that contribute to aroma such as fermented soy sauce, cinnamon, and cloves.

No significant (P>0.05) difference was found between commercial seaweed snack and mixed green tea leaves with vegetables snack (i.e. GWS, GS, and GK) on stickiness and fracturability. The stickiness of all snacks ranged from 5.35 to 5.53 while fracturability of all snacks ranged between 5.58 and 6.10 (Table 4). According to Ho and Abdul Latif (2016), food product received higher than 4.00 score can be considered as acceptable to consumers. Therefore, consumers can accept the mixed green tea leaves with vegetables snack in terms of stickiness and fracturability.

The cohesiveness and chewiness of mixed green tea leaves with vegetables snack i.e. GWS was significantly (P<0.05) lower than that control (CS). The panelists had scored the cohesiveness and chewiness of the commercial seaweed snack at 6.00 and 6.30, respectively (Table 4). While mixed green tea leaves with water spinach (GWS) snack had scored of cohesiveness and chewiness at 5.25 and 5.60, respectively. This was due to

the present of stem from green tea leaves that make it to break easier and take time to chewy which less preferred by consumer.

Table 4. Sensory evaluation of commercial seaweed and mixed green tea leaves with vegetables snacks.

Attributes	Types of sample			
	CS	GWS	GS	GK
Aroma	$6.48^{b} \pm 0.78$	$5.13^{a} \pm 1.04$	$4.90^{a} \pm 1.19$	$5.00^{a} \pm 1.13$
Stickiness	$5.53^{a} \pm 1.34$	$5.45^{a} \pm 1.13$	$5.35^{a} \pm 1.17$	$5.40^{a} \pm 1.37$
Fracturability	$6.10^{a} \pm 1.03$	$5.58^{a} \pm 1.15$	$5.63^{a} \pm 1.29$	$5.65^{a} \pm 1.25$
Cohesiveness	$6.00^{b} \pm 0.96$	$5.25^{a} \pm 1.21$	$5.48^{ab} \pm 1.18$	$5.43^{ab} \pm 1.24$
Chewiness	$6.30^{b} \pm 0.85$	$5.60^{a} \pm 1.17$	$5.68^{ab} \pm 1.19$	$5.55^{a} \pm 1.11$
Overall Acceptability	$6.63^{b} \pm 0.49$	$5.50^{a} \pm 1.18$	$5.50^{a} \pm 1.01$	$5.38^{a} \pm 1.10$

Data are mean±standard deviation (n=40). Values with different superscript letters within a row are significantly different ($p < 0.05$).
CS: commercial seaweed snack (control); GWS: green tea leaves with water spinach; GS: green tea leaves with spinach; GK: green tea leaves with *Kailan*

All the mixed green tea leaves with vegetables snacks were acceptable as they received scores greater than 4, ranged from 5.38 to 5.50 (Table 4). The panelists rated the control as the highest score (6.63) for overall acceptability. Mixed green tea leaves with spinach was comparable to the control in term of the stickiness, fracturability, cohesiveness and chewiness. For future, the mixed green tea leaves with vegetables snack can be reformulation with addition of aromatic ingredients which will enhance the aroma and taste. Therefore, mixed green tea leaves with vegetables snack has potential to be substituted for commercial seaweed.

CONCLUSION

Mixed green tea leaves with vegetables snack can be developed for those allergic to seafood and vegetables adverse. Mixed green tea leaves with vegetables snack had higher ash, crude protein, crude fiber, crude fat, and energy but lower in moisture and carbohydrate than the commercial seaweed snack. The texture of mixed green tea leaves with spinach (GS) was similar to the commercial seaweed snack in terms of fracturability, adhesiveness, gumminess and chewiness. Mixed green tea leaves with vegetables snacks had lower hardness values but higher cohesiveness values than the commercial seaweed snack. The mixed green tea leaves with vegetables snacks had similar ratings by the panelists in attributes of stickiness, fracturability, cohesiveness and chewiness. However, mixed green tea leaves with vegetables snacks were acceptable based on ratings (> 4.0 score) by the panelists.

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