Original article

Evaluation of physical characteristics and sensory acceptance of newly developed vegetable-based soups

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Abstract. The average vegetables consumption of Malaysian children is relatively low and do not meet the recommendations set by Malaysian Dietary Guidelines. Serving vegetables in the form of blended soup may increase vegetable consumption among children. This study aimed to evaluate physical characteristics of newly developed vegetable-based soups and their sensory acceptance by Malaysian children from three main ethnicities. Three different soups were prepared by blending potatoes with different ratios of carrots, celery and leek. Soup A was made with 25 g of each type of vegetable, soup B was made by doubling the amount of vegetables used in A, and soup C was the same as soup B but with 50% more carrots. In terms of colour measurement, the L* value was significantly lower (p<0.05) in soup C than soups A and B, whereas the colour intensity of redness (a^*) and yellowness (b^*) was significantly higher (p<0.05). Mean sensory scores for attributes of colour, saltiness, sweetness and overall acceptance were highest for soup C. For the attribute of taste, mean score of soup C (5.4±2.2) was significantly higher (p<0.05) than that for soup A (3.3±2.0) among Malays, while no significant differences (p>0.05) were observed among Chinese and Indians. In conclusion, the vegetable soup with extra carrots was well-accepted by children from all three ethnicities and may be adopted as a dietary strategy to increase children's vegetable intake.

Key words: soup, vegetable, physical characteristics, sensory, children

Introduction

Childhood obesity is a chronic disorder caused by an imbalance between energy intake and energy expenditure (1,2), which results in excessive body fat accumulation and adverse effects on the current and future health of children (3-5). Over the past decades, childhood obesity has dramatically increased at an alarming rate (6). In 2016, 50 million girls and 74 million boys worldwide were classified as obese (7).

Childhood obesity track strongly into adulthood and increase the risk of non-communicable diseases, such as hypertension, diabetes and dyslipidemia (8-10). A previous study even noted that severe obese children were associated with lower cognitive performance (11). Due to the established health consequences and significant increases in prevalence, obesity has become one of the most critical public health challenges throughout the world (12,13).

Malaysia is a rapidly developing Southeast Asian country where the prevalence of childhood obesity is also rising rapidly. A nationwide survey, which assessed the nutritional status of 3542 children reported that approximately 34.5% of primary school-aged children living in urban areas were either overweight or obese (14). Meanwhile, according to the National

Health and Morbidity Survey of 2019, approximately one-third of children and adolescents aged 6-17 years were classified as overweight or obese (15). Currently, the issue of childhood obesity is considered as a public health priority in Malaysia (16,17).

Considering that food intake patterns established during childhood continue into adulthood (18-20), it is crucial to implement effective public health strategies to optimize nutritional status and to prevent childhood obesity during the critical years of growth (21,22). A well-balanced diet that incorporates all the major food groups is essential to ensure the overall health and adequate growth in children. In recent years, the Malaysian diet has transformed to a 'westernized' dietary pattern, accompanied by higher intake of energy, fat and sugar due to rapid urbanization and industrialization (23-25). Previous studies have reported that the food consumption of Malaysian children does not meet the Malaysian Dietary Guidelines (MDG) recommendations for all food groups, viz., cereals/grains, fish, legumes, milk/dairy products, fruits and vegetables, except for the meat/poultry food group (26,27).

Approximately 31% of ischemic heart diseases, 19% of gastrointestinal cancer and 11% of stroke cases were caused by insufficient consumption of fruit and vegetables, with about 3 million deaths per year contributed by those non-communicable diseases around the world (28). In Malaysia, it has been reported that the consumption of fruit and vegetables in adults is far below the recommendations for optimal health (29). Furthermore, less than one-fifth of Malaysian children aged 1-6 years achieved the recommended daily portion of fruit (11.7%) and vegetables (15.8%) (30). More alarming is that more than 80% of primary school children in Malaysia aged 7-12 years reportedly do not meet their recommended daily consumption of fruit and vegetables (27). The reasons include socio-demographic factors, dietary habits, social influences, taste preferences, and the availability and accessibility of fruits and vegetables at home (31-33). Urgent action is needed to promote the consumption of fruit and vegetables in Malaysia (34). It has been reported that promoting the consumption of vegetables among children is a challenging process (35,36). This may be due to the children's dislike of the appearance and bitter taste of certain vegetables (37-38). Besides the well-known benefits of vegetables in the prevention of chronic diseases, vegetables are also good sources of fibre with low glycaemic index that helps in increasing gastric distension, decreasing gastric emptying rate, and altering the secretion of satiation hormones, such as ghrelin, thereby increasing the feeling of satiety (39-41).

A possible strategy to reduce total energy intake and increase the intake of vegetables among Malaysian children is to introduce a vegetable-based soup into their diet. Some studies have reported that liquid foods are less satiating than solid foods (42-44). However, liquid foods, such as soup, broth, and puree, have proven to be successful in reducing appetite and energy intake (45-46). A study on the satiating effect of three isoenergetic preloads, namely apple juice, apple soup and apple (fruit) observed that the consumption of apple soup contributed to a lower rating of postprandial hunger (47). This implies that soup consumption gives a satiating effect and is beneficial in lowering energy intake when served as preload (47). A more recent study reported that the effect of soup in suppressing appetite is due to a delay in gastric emptying and an increase in glycaemic response (48). Apart from that, in terms of diet quality, soup consumption was associated with a higher total diet quality score for total vegetables, legumes, dark green or orange-coloured vegetables (49). From the same study, the intake of dietary fats and added sugar was observed to be lower among soup consumers. Moreover, obese women provided with a fixed preload vegetable soup could enhance their satiety and decrease their consumption of high-fat savoury food during a subsequent ad-libitum meal (50). Meanwhile, a study performed in France also supported that the intake of soups negatively correlates with BMI and fat intake (51).

Collectively, the above-mentioned findings suggest that the intake of vegetable-based soup could be a good way to increase vegetable intake and reduce total energy intake in children. Also, soup is easier to swallow, which is helpful especially for children who dislike the fibrous texture of vegetables. To accomplish the objectives above, a newly developed vegetable soup should be as consistent as possible with children's preferences. However, the varied eating patterns and cultures of different ethnicities may lead to different food preferences. For instance, a study has reported that the dietary patterns of adolescents from different ethnic groups were distinctive (52). Therefore, considering the variations in taste preference amongst different ethnic groups is ultimately important when introducing a vegetable-based soup that can potentially appeal to multiple ethnic groups in order to increase vegetable intake. While several countries have developed nutritious soup recipes (53-54), these recipes may not be suitable for children in such multi-ethnic countries as Malaysia. Thus, the aim of this study is to evaluate the physical characteristics of newly developed vegetable-based soups and their sensory acceptance by children from the three major ethnic groups in Malaysia.

Materials and methods

Development of vegetable-based soup

Potato, carrot and celery are root and leafy vegetables that are commonly consumed by Malaysians (55). Based on available recipes, a new recipe for vegetable soup was developed. The ingredients initially included russet potatoes, carrots, celery, leeks, butter and milk. Considering that the soup recipes developed for Western palates may not suit the local Malaysian palate, the recipe was reformulated. Pilot sensory tests were conducted with seven consumer panellists: a chef, university lecturers with nutrition background, and researchers (data not shown). The panellists tasted the soups and considered availability, cost, and nutrient content of the ingredients for the soups. Using information gleaned from the panellists' discussion, an alternative list of ingredients was developed, using readily available vegetables in Malaysia for the soup. Hence, russet potatoes were replaced with Holland potatoes, considering the availability and lower cost of the latter. To enhance the flavour of the vegetables, butter was replaced with olive oil. Hence, the final ingredients comprised Holland potato, carrot, celery, leek, milk and olive oil. Three soup formulas were created (soups A, B, C) using different proportions of these vegetables.

All the soups were prepared in a food preparation laboratory on the day prior to the evaluation. The raw carrots, celery, and leeks were sorted, washed and cut into cubes. The potatoes were boiled for 30 minutes until tender and then peeled. The vegetables were stir-fried with olive oil. One litre of water was added and the mixtures were brought to a boil. The potatoes were then added and the mixture was simmered for another five minutes. To obtain a smooth texture, the soups were blended in a commercial blender (Panasonic MS800S, Malaysia) for 6 minutes. After blending, the soup was returned back to the cooking pot. Milk was added and the soup was then simmered for 30 minutes and continuously stirred. Salt was added for seasoning. The soups were then cooled down and kept in the refrigerator at 4°C overnight. Prior to the sensory evaluation, the soups were reheated and transferred to a thermos flask. All preparation methods were standardized in order to ensure that the soups were of the same consistency.

Proximate composition of soups

Nutrient composition of the soups was determined using proximate analysis based on the AOAC methods (56). Both crude protein content and crude fat content were determined using the Kjehdahl and Soxhlet methods, respectively. The carbohydrate content was calculated using the following formula: carbohydrate content = [100% - (ash + moisture + protein + fat)%].

Energy and dietary fibre content of soups

Total energy content of the soup was calculated by adding up the energy provided by protein, fat and carbohydrate content. Total dietary fibre content of the soups was analysed, based on AOAC gravimetric method 985.29.

Physical characteristics of soups

The colour of three different soup samples was assessed by using Konica Minolta Chroma Meter CR-400 (Osaka, Japan). L^*, a^* and b^* values to describe three-dimensional colour space were measured and interpreted as follows: the L^* value corresponds to lightness and ranges from 0 (black) to 100 (white); the parameter a^* represents redness, ranging from negative value of green to the positive value of red; whereas the parameter b^* represents yellowness, ranging from negative value of blue to the positive value of yellow. The colour measurements for each soup sample were performed in triplicate at room temperature.

The viscosity of the soups was measured in duplicate by using CAP1000 viscometer (AMETEK Brookfield, USA) at the spindle speed of 10 rpm. Temperature was controlled at 22 ± 1 °C during the viscosity measurement.

Sensory evaluation

All participants were requested to complete the sensory evaluation in a vacant classroom at their respective school. To minimize distraction, temporary individual sensory booths were constructed by using portable heavy cardboards as partitions. The booths were set up under fluorescent lighting with white-colour light and with noise and odour kept to a minimum. Participants were separated into groups and only three participants were allowed in the classroom each time for the sensory evaluation. Each participant was requested to complete the evaluation individually without communicating with each other. An explanation of how to rate the hedonic scale was provided by trained researchers prior to the evaluation. Prior to tasting each soup sample, the participants were asked to drink some distilled water to cleanse their palates. A white tray with the three different soup samples, a plastic spoon, a cup of water, a napkin, a test form and pen were provided to the participants. The three different soup samples were served in 50 ml small containers with lids at 68-72°C in random order and coded with randomized 3-digit number codes to avoid bias. The participants were encouraged to taste at least one teaspoon of the first soup sample by using the provided spoon (they did not have to consume the entire sample). They were then requested to evaluate the acceptability of the soups by rating the sensory attributes, including colour, aroma, saltiness, sweetness, creaminess, and overall acceptance by using a seven-point facial hedonic scale that express feelings from: 1=dislike strongly (most frowning) to 7=like strongly (most smiling) (57-58). The same procedure was repeated for every soup sample.

Participants

A total of 43 children aged 9 to 11 years from primary schools in the Kuala Lumpur metropolitan area, Malaysia were recruited for this study. There were 15 Malay, 15 Chinese and 13 Indian students, representing the three main ethnic groups in Malaysia. Participants with food allergies or who were intolerant to milk and those with any medical conditions that could influence their food taste and smell, were excluded from this study.

This project was approved by the Research Ethics Committee of Universiti Kebangsaan Malaysia (Ref No. UKM PPI/111/8/JEP-2017-594). Permission to conduct the study in primary schools was obtained from the Ministry of Education and school principals prior to data collection. Written informed consent was obtained from the parents or guardians of all the subjects and verbal assent was obtained from each child before data collection.

Statistical analysis

Mean and standard deviations (SD) were used to describe continuous variables with normal distribution. Mean descriptive scores for each sensory attribute were calculated. Data analysis was performed with IBM SPSS for Windows, version 22.0 (IBM Corp, Armonk, NY, USA). One-way ANOVA tests were used to compare colour parameters, viscosity and sensory attributes among the three different soups and ethnicities. Tukey's HSD post-hoc test was used to compare the differences. p-values below 0.05 were regarded as significant.

Results

Ingredients of soup recipe

The chief ingredients that provided flavour in the soup formulation included potatoes, carrots, celery and leek, with potatoes being the main ingredient (Table 1). Other ingredients that imparted some flavour to the soups were milk, olive oil and salt.

Proximate, energy and total dietary fibre content of the soups

The energy contents of soups A, B and C were 30 kcal/100g, 32 kcal/100g and 33 kcal/100g, respectively. Based on proximate analysis, soup C had a significantly higher (p<0.05) amount of carbohydrates, protein and fat, compared to soup A and B. Similarly, the dietary fibre content in soup C (1.45 g/100g) was the highest, followed by soup B (1.30 g/100g) and soup A (1.15 g/100g), although no significant differences were observed (Table 2).

Physical characteristics of soups

The three soup formulations have significantly different colour parameters (L^*, a^* and b^*) as shown in Table 3. The L^* parameter, which denotes lightness, was significantly higher (p<0.05) in soup A, compared to soups B and C. This denotes a lighter colour in soup A. As expected, soup C, which contained the highest proportion of carrots, had significantly higher (p<0.05) values of (a^*) (reddest hue) and (b^*) (yellowest hue) when compared with soups A and B.

It was noted that soup C had the highest viscosity (1204 ± 843 cP), followed by soup B (906 ± 416 cP) and soup A (865 ± 361 cP), but no significant differences (p=0.827) were observed among the three soup recipes.

Sensory evaluation of three soups formulation

The mean score for taste attribute in soup C (5.4 ± 1.7) was significantly higher (p<0.05) than soup A (4.4 ± 1.9) (Table 4). Mean score for creaminess attribute in soup C (5.4 ± 1.3) was also significantly higher (p<0.05) than soups A (4.6 ± 1.8) and B (4.6 ± 1.6). Similarly, mean score for attributes of colour, aroma, saltiness, sweetness and overall acceptance appears to be highest for soup C, even though there was no statistical significance observed among the soups

Table 1. Ingredients, brands and amounts used in soup recipes.

Ingredients	Country of Origin	Soup A	Soup B	Soup C
Potato (g)	Holland	400	400	400
Carrot (g)	Australia	25	50	75
Celery (g)	Australia	25	50	50
Leek (g)	Malaysia	25	50	50
Extra virgin olive oil (tablespoon)	Spain	1	1	1
Full cream milk (mL)	Malaysia	250	250	250
Added salt (g)	Malaysia	5	5	5

Table 2. Composition of energy and nutrient compositions in 100g of soup (Mean±SD).

Parameters	Soup A	Soup B	Soup C
Energy (kcal)	30 ± 0[a]	32 ± 0[b]	33 ± 0[b]
Carbohydrates (g)	5.27 ± 0.07[a]	5.60 ± 0.06[b]	5.85 ± 0.13[b]
Protein (g)	0.91 ± 0.01[a]	0.94 ± 0.00[b]	0.96 ± 0.01[c]
Fat (g)	0.53 ± 0.01[a]	0.60 ± 0.02[b]	0.65 ± 0.01[c]
Dietary fibre (g)	1.15 ± 0.07	1.30 ± 0.14	1.45 ± 0.21

[1]Proximate analysis and total dietary fibre content of each soup were performed in duplicate.
[abc]Mean values in the same row which are not sharing the same superscript letter showed a significant difference at p<0.05 based on one-way ANOVA. Tukey's HSD post-hoc test was used to compare the differences.

Table 3. Physical characteristics of soups (Mean±SD).

Parameters	Soup A	Soup B	Soup C
L^*	67.7 ± 0.09[a]	66.21 ± 0.09[b]	65.33 ± 0.19[c]
a^*	-4.53 ± 0.04[b]	-4.84 ± 0.03[a]	-3.05 ± 0.08[c]
b^*	27.41 ± 0.10[a]	31.96 ± 0.06[b]	36.44 ± 0.14[c]
Viscosity (cP)	865 ± 361	906 ± 416	1204 ± 843

[abc]Mean values in the same row which are not sharing the same superscript letter showed a significant difference at $p<0.05$ based on one-way ANOVA. Tukey's HSD post-hoc test was used to compare the differences.
[1]The L^* value corresponds to lightness and ranges from 0 (black) to 100 (white); the parameter a^* represents redness, ranging from negative value of green to the positive value of red; whereas the parameter b^* represents yellowness, ranging from negative value of blue to the positive value of yellow.

Table 4. Mean score for sensory characteristics of soups by children (n=43) (Mean ± SD).

Characteristics	Soup A	Soup B	Soup C
Colour	4.7 ± 1.7	5.0 ± 1.6	5.3 ± 1.4
Aroma	5.3 ± 1.5	5.7 ± 1.4	5.7 ± 1.2
Taste	4.4 ± 1.9[a]	4.9 ± 1.8[ab]	5.4 ± 1.7[b]
Saltiness	4.4 ± 1.7	4.3 ± 1.7	4.5 ± 1.6
Sweetness	4.7 ± 1.7	4.9 ± 1.6	5.0 ± 1.8
Creaminess	4.6 ± 1.8[a]	4.6 ± 1.6[a]	5.4 ± 1.3[b]
Overall Acceptance	4.8 ± 1.9	5.3 ± 1.5	5.6 ± 1.8

[ab]Mean values in the same row which are not sharing the same superscript letter showed a significant difference at $p<0.05$ based on one-way ANOVA. Tukey's HSD post-hoc test was used to compare the differences.

(colour: $p=0.267$; aroma: $p=0.229$; saltiness: $p=0.870$; sweetness: $p=0.844$; overall acceptance: $p=0.090$).

Comparison of sensory evaluation among ethnicities

No significant differences ($p>0.05$) could be observed based on the participants' ethnicities for most of the attributes of the soups, except for the taste attribute. Among Malay children, the mean score for taste attribute for soup C (5.4±2.2) was significantly higher ($p<0.05$) than soup A (3.3±2.0) but there was no significant difference ($p=0.530$) when compared to soup B (4.9±1.9), as shown in Figure 1.

Discussion

The main ingredients of the newly developed vegetable-based soups included potatoes, carrots, celery and leeks. Three vegetable-based soups were successfully developed as the mean scores of the three soups for all attributes, namely colour, aroma, taste, saltiness, sweetness, creaminess and overall acceptance were categorized as good. However, for the taste attribute, soup A was less well accepted than soups B and C, while soup C was the best accepted soup, with the highest mean score for all the attributes.

The colour of food is known to affect consumers' interest in eating the same (59) and can therefore influence whether children eat their vegetables. For instance, brightly coloured vegetables, unlike dark green vegetables, have been shown to be more acceptable (60-62). For objective colour measurement, the parameter a^* is positive for reddish colours and negative for greenish ones. In the current study, the proportion of greenish-coloured vegetables (celery and leeks) used in the three soup recipes was relatively higher than that of reddish-orange coloured vegetable (carrots). Hence,

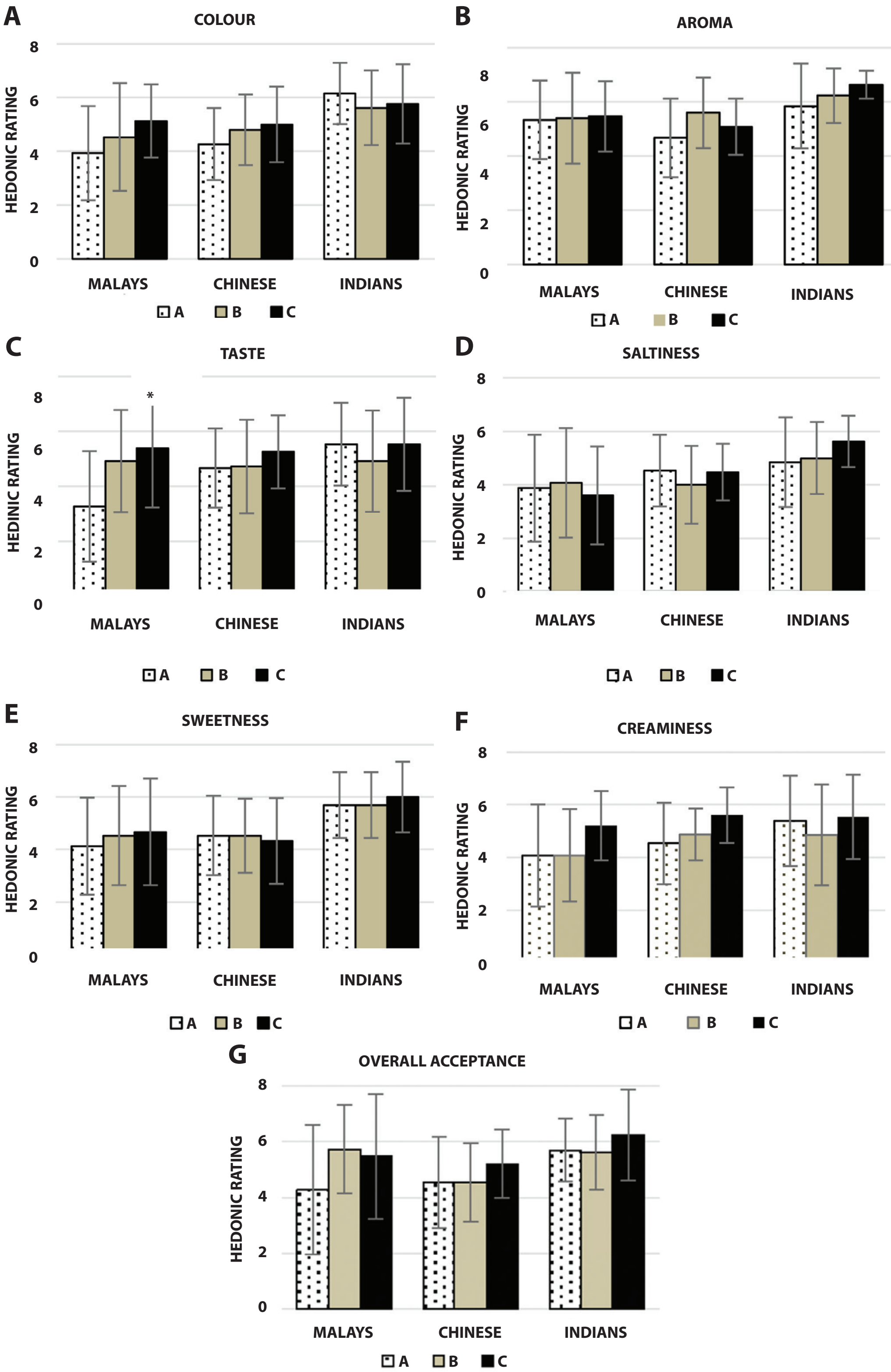

Figure 1. Comparison of sensory ratings among three different types of soup by ethnicity. (A) Colour; (B) Aroma; (C) Taste; (D) Saltiness; (E) Sweetness; (F) Creaminess; (G) Overall acceptance. The error bars represent the standard deviation of measurements (n = 43).

a* value for the three soups were negative. Meanwhile, soup C has the highest amount of carrot, which contributed to the reddish-orange colour of the soup; therefore, it had the highest value of (-a*) in the colour measurement. Also, mean scores for colour, sweetness and overall acceptance of soup C were the highest in the sensory evaluation. This finding is consistent with a previous study, which suggested that children preferred mild and sweet tasting vegetables, such as cooked carrots compared with spinach (63). A possible explanation for the non-significant result for the attribute of colour and sweetness among the three soup recipes is that the differences in the amount of carrot added was too small (i.e. 25 g difference between each soup) to make a difference in sensory attributes.

A previous study has suggested that aroma may have a negative impact on the acceptance of vegetables. It was observed that, although the soups in our study contain vegetables, such as celery and leek, that most children have been known to dislike when presented in their original forms (63), the mean score for aroma was still considered good, and was acceptable to the children. Temperature tended to affect the perception of sweetness (64). It is speculated that the heating and blending process combined and balanced the flavours of all the soup ingredients (65). Therefore, no significant difference was noted among the soups for the attribute of aroma (p=0.229) and overall acceptance (p=0.090). On the other hand, the same amount of salt was added to all the three soups to ensure that they had the same sodium content; thus, the attribute of saltiness was also fairly well-accepted with no significant difference (p=0.870) observed.

Creaminess is a significant complex sensory attribute that affects consumers' acceptance (66). The perception of creaminess is primarily related to textural sensations (thickness and smoothness) and flavour (dairy and sweet) (67). In this study, milk contributes directly to the creamy texture of the vegetable-based soups. Although a similar volume of milk was added to each of the three soups, the results revealed that soup C had a significantly higher (p<0.05) mean score for the attribute of creaminess. This finding is consistent with a previous study which showed that dietary fibre can induce thickening when mixed with liquids (68). We speculate that soup C, which contained the highest amount of dietary fibre, had a thicker texture after blending. The mean score for the attributes of creaminess was therefore significantly higher (p<0.05) in soup C.

Food preferences may vary among the three ethnic groups due to different socio-cultural and religious practices (27, 69). In the current study, no significant difference (p>0.05) was observed among ethnicities for most of the sensory ratings of the soups, except for the attribute of taste. Among Malay children, soup C had significantly (p<0.05) better mean score for the attribute of taste than soups A and B. This finding, again, suggests that soup C can be considered as the most acceptable soup for children. Each of the ingredients for the newly developed vegetable-based soups may provide different nutrients to children. Potatoes offer higher levels of vitamin C (13mg/100g), compared with other starchy foods, such as pumpkin (5mg/100g) and corn (5.5mg/100g), according to the USDA Food Composition Database (70). Since less than 40% of Malaysian children achieved the Malaysian Dietary Guidelines (MDG) recommendation for the food group of cereal, cereal products and tubers (27), potato, as the main ingredient in our vegetable soup can help increase the consumption of tubers. Celery is a good source of vitamin K, folate, potassium, fibre and molybdenum and is also rich in phytonutrient antioxidants, such as flavonoids and tannins that contain anti-inflammatory properties (71). Research shows that the allicin compound found in leeks have anti-bacterial, anti-viral, anti-fungal and antioxidant properties (72). In addition, it had been found that consumption of carotenoids in carrots improved immunity and enhanced cognitive ability (73). Full cream milk can facilitate appetite control and the fatty acids in milk products may protect against weight gain (74). Thus, in our soup recipes, the milk added to the soups not only provides the creamy texture, it may also help in increasing the feeling of satiety, which in turn helps avoid the over consumption of food. Based on the results of our study, soup C had the highest amount of dietary fibre (1.45 g /100 g) and was also the most viscous (1204 ± 843 cP). This agrees with a previous study that suggested that dietary fibres, including those found in fruits and vegetables, have the properties of adding bulk and producing viscosity (75). Moreover, the dietary fibre intakes of local children and adolescents have been reported to be low (76). Therefore, serving a cup of soup C (250 g) would potentially enable children to meet approximately one-fifth of their daily requirement of dietary fibre based on the Recommended Nutrient Intakes (RNI) for Malaysia (13). Most importantly, the calorie count for a cup of soup C was only 83 kcal. The previous nationwide survey had classified one-third of Malaysian children as overweight or obese (14). Taken together, it is worthwhile considering using soup C as a dietary strategy to increase vegetable intake and feelings of satiety among Malaysian children as dietary fibre is well known for promoting satiety (77).

When interpreting the current findings, there are several limitations and strengths that need to be taken into account. In this study, we used a seven-point facial hedonic scale, which was child-appropriate to measure their preference of soup. However, some children may not be able to evaluate each sensory attribute as accurately as adults, as their cognitive abilities are still developing. Furthermore, the current study was carried out only in the Kuala Lumpur metropolitan area with fewer subjects. Hence, the acceptance of the vegetable-based soups may not be generalizable to the population of all children in Malaysia, as geographic differences may also influence food preferences. In addition, it may be a challenge for children to consume the soup frequently as the newly developed soup has a short shelf life and can only be stored for approximately two days under refrigeration. Therefore, it is proposed that collaboration can be formed with the food industry to adopt the newly developed soup recipe as a ready-to-serve canned or dehydrated soup, which can be introduced as a new food product to the market. This will give the soup a longer shelf life, and make it more easily accessible and convenient, with a short preparation time. However, for further development of the vegetable-based soup as a new commercial product, food safety, quality testing, shelf-life testing and additional consumer sensory testing on a larger scale will be required.

Among the strengths of our study is that the newly developed vegetable soup, particularly soup C, was well-accepted by Malay, Chinese and Indian children. By considering that taste preferences differ among ethnicities, the subjects of the current study comprised children from the three main ethnic groups which represent the demographics in Malaysia. Another strength would be that the soups were prepared without using any broths, for example chicken broth, which would have made the soup preparation process more complicated and raised the energy content of the soups; and yet they were rated to be tasty and was well-accepted by the multi-ethnic children who participated in this study.

Conclusions

The newly developed vegetable soup, namely soup C, was well-accepted by children from multi-ethnic backgrounds. Soup C, which has extra carrots was also found to have the highest value in physical characteristics, in terms of viscosity and colour intensity. Serving this newly developed vegetable soup to children could be a potentially effective strategy for parents and schools to increase children's vegetable intake. When used as a preload, this soup also has the possibility to reduce energy intake in a subsequent meal. Further research should involve larger samples from different geographical areas and investigate the effects of this newly developed vegetable soup on satiety and fibre intake.

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