Using sensory and mood perceptual maps for generating new energy drink product ideas

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Abstract

To understand how consumers differentiate marketed beverage products for energy providing, perceptual mapping is a technique generally used. Repertory Grid method (RGM) and face to face interviewing were used to construct the sensory characteristics and preferred moods relating to energizing and rate intensity of them after drinking six selected beverage samples. Then Generalized Procrustes analysis (GPA) derived both of sensory and mood perceptual maps from these data. The directions of overall liking from both perceptual maps were used to describe which beverages responded the most to preferred moods. It also provided the sensory characteristics of the selected beverages. Apparently, carbonated water and caffeine drinks contributed to high levels of the most preferred moods such as relaxation, activeness, revitalization, refreshment, energizing and alertness more than other drinks. These two drinks were flavored most due to their sensory characteristic of 'moistness left in the throat' and 'transparency'. Thus, the trend to develop the fruit juice drink for increasing energy should follow the positive sensory characteristics of both beverages as a guideline.

Introduction

Referring to reviews on the impacts of energy drink on mood by Smit and Rogers (2002), that of this research interest in investigating sensory characteristics of energy drinks relate to preferred moods. Lyman (1989) and Shiebler (2004) pointed out that consumers used beverages to increase energy more than food and other things because fluids pass through and are absorbed by the body easier and faster. Therefore energy drinks become a preferred beverage taken for feeling more energized and related moods (Smit and Rogers, 2002) when losing energy due to hard work or over exercise (Thanalertkul, 2005).

Energy drinks are advertised as high energy generators, therefore creating energy at a faster rate, hence a shorter rest is needed than when drinking water (Smit and Rogers, 2002). However, most of the marketed power drinks in Thailand contain caffeine which has effects on Central Nervous System (CNS) (Davis *et al.*, 2003). Thus, the drinks may present negative psycho-stimulant effects on the human body (Smit and Rogers, 2000). Hence new energy drinks were created without caffeine. The research

interest is marketed beverages such as fruit juices, in substitution of caffeine drinks to increase energy.

Consumers who felt losing energy have used fruits instead of vitamin and mineral supplements to regain energy (Johnson, 2005). Tropical fruit juices are important sources of vitamins and energy (Hengsawasdi, 2002; Sanz *et al.*, 2004; Bansiddhi, 2004). The benefits of taking fruit juice include; good for health (Shiebler, 2004), quick energy regain (Bansiddhi, 2004), ease of digestion, speed of absorption (Turner, 2001) and energizing mood creation. There are academic reports about the potential fruit juices that could be used for energy support. These include mangosteen (Templeman, 2005), longan (Public Division, Ministry of Public Health, Thailand and Tourism Authority of Thailand, 2005) and banana (Karcher, 2003; Howell, 2005), etc. However there is no known research on energizing mood increasing by these fruits.

The concept regarding sensory characteristics of energy drinks from fruits used in this study was developed from qualitative and quantitative techniques such as one-on-one interviewing with questionnaire and Repertory Grid Method (RGM) (Gains, 1994).

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Perceptual mapping relating to moods was created from marketed beverages, which are claimed for energizing or relevant moods by consumer tasting. The results from perceptual maps are the guidance for production of fruit juice drinks. The opportunity of fruit juice drinks on energizing mood compared to marketed beverages in the consumer views is also explored.

Perceptual mapping is a technique generally used to understand how consumers differentiate products in perception of sensory characteristics, context of uses, etc. This technique was applied to create new beer product ideas previously (Khajarern, 2001) but mood perceptual map has never before been used.

In this research, consumer perceptions of energizing and related moods were explored using rating questions in a questionnaire survey by consumer panels. The key sensory characteristics which consumers preferred in the beverages for use of increasing energized mood were investigated using consumer panels. The RGM was hence employed in a taste test.

Materials and Methods

There were 2 steps for this study; step 1 is screening beverages samples for increasing energy and step 2 is investigation of sensory characteristics relating to preferred moods of beverages consumed for increasing energy purpose

Screening beverage samples for increasing energy

To select an appropriate number of beverage samples to be tested using RGM in the next step, thirty three marketed beverage samples were classified by fifty subjects (Resurreccion, 1998) into energy and non-energy drink groups. Then the samples perceived in usage of increasing energy from the subjects' past behaviour, were ranked into the first three orders which were most consumed or preferred to use for feeling more energy. The beverage ranking data was analyzed by calculating frequencies on first three orders.

Samples

Thirty three marketed beverage products (Table 1) were selected using convenience sampling at a local superstore in Nongkhai province, Thailand. The samples were presented in their packages using controlled temperature at 4-6 ºC for a test by subjects.

Subjects

Fifty consumer panels, of which 24 females (mean age was 23.0 ± 3.8) and 26 males (mean

Table 1. List of thirty three marketed beverage products

1. Drinking water	2. Spring water	3. Electrolyte drink
4. Sparkling water	5. Carbonated soft drink	6. Lemonade soft drink
7. Essence of chicken soup	8. Bird's nest soup	9. Mixed vegetable juice
10. Carrot juice	11. L-carnitine drink	12. Amino acid drink
13. Mixed fruit juice	14. Coconut juice	15. Longan juice
16. Mangosteen juice	17. Mango juice	18. Orange juice
19. Aloe vela juice	20. Collagen drink	21. Floral drink
22. Herbal fruit juice	23. Prune juice	24. Banana juice
25. Syrup drink	26. Lemon tea beverage	27. Green tea beverage
28. Coffee drink	29. UHT milk	30. Malt drink
31. Drinking yoghurt	32. Soy milk	33. Caffeine drink

age was 23.0 ± 4.7) were recruited using purposive sampling to the sensory laboratory of Food Technology Department, Khon Kaen University, Nongkhai Campus, Thailand. Individuals were willing to participate in this study.

Methods

All samples were presented to individual subject for classifying into energy and non energy beverage groups according to their perceptions. Then the samples perceived and classified as energy drinks were ranked in first three orders on perceived benefits for energizing mood, based on consumers' experiences.

Consumer panels were required to complete the questionnaires asked in 6 parts; they were 1) moods related to energy, 2) energizing related experiences, 3) opinions of the opportunity and possibility of fruit juice drinks to be used as energy drinks, 4) sensory characteristics of the drinks preferred for the use of increasing energy, 5) preferred moods after drinking the beverages and 6) general demographic information of individuals in Thai or English versions, respectively.

Data analysis

Ranking data of the top three, most preferred drinks consumed for increasing energy purpose from fifty subjects, were analyzed by calculating frequencies (Hayes, 1998). The top ranks of most consumed or preferred to use beverage chosen for increasing energy were then used as samples in a taste test in order to retrieve a list of key sensory characteristics of the beverages using RGM.

Investigation of sensory characteristics relating to preferred moods of beverages consumed for increasing energy purpose

To find out a list of sensory characteristics of beverages which consumer panels drink in anticipation of generating their preferred moods after drink. RGM and face to face interviewing were conducted for this study.

Samples

The first six ranks of marketed beverage products

which were summarized in highest frequency from all subjects who consumed and preferred to use them for increasing energy. They were 'orange juice drink' (A), 'drinking water' (B), 'green tea beverage' (C), 'electrolyte drink' (D), 'caffeine drink' (E) and 'carbonated soft drink' (F) with range of most frequencies. All six samples were then tasted to elicit the sensory characteristics of beverages which subjects drink for increasing energy.

The samples were presented in triads, for example; ABC, CDE and EFA. Thus the three triads were all presented in a randomized order to individual subject. Each sample was served in a clear plastic container and closed covers for 25 ml, each, of temperature 4-6 $^{\circ}$C and encoded with three digit random numbers to avoid any biases.

Subjects

20 consumer panels (Scriven *et al.* in 1989 used 20 subjects to investigate the contexts using RGM in which they typically consumed a range of alcoholic beverages), of which 10 females and 10 males (age ranged between 18-35 years) were recruited using purposive sampling at local exercise centre and gyms, to sensory laboratory of Food Technology Department, Khon Kaen University, Nongkhai Campus, Thailand. They were willing to participate in this study.

Methods
Repertory grid method (RGM) (Gains, 1994)

The RGM was conducted for investigation of sensory characteristics in food products. This technique involves two phases: construct elicitation using samples, and ratings intensities for each construct of the sample. The six beverage samples were used to elicit a list of sensory characteristics from each of the twenty consumer panels, using triadic presentation and the question, 'in what sensory characteristics are these two samples similar to one another but, in the same way, different from the third?' After tasting each sample, each consumer was subsequently asked to rate intensity of the derived sensory attributes, individual own lists of product characteristics, on a 100 mm Visual Analogue scale (VAS) with anchor points labeled 'none' and 'extremely'. The overall liking was also rated by each consumer after rating all sensory characteristics.

Face to face interview (FFI) (Pridemore et al., 2005)

The FFI was conducted in order to define and construct preferred moods after drinking each sample. Each of the twenty consumer panels was asked the following: 'What are preferred moods or feelings after drinking the drink which feels more energy?' The interview was conducted one by one for each consumer. Afterwards, the subjects were subsequently asked to rate their feeling level after tasting each sample for its preferred mood for individual own lists, on a 100 mm VAS with anchor points labeled 'none' and 'extremely'. Then, the overall liking was rated by each consumer after rating all desired symptoms.

Data analysis

Generalized Procrustes Analysis (GPA; Gower, 1975) using XLSTAT statistical package (XLSTAT-MX/GPA developed by Jaeger in 2007, Addinsoft de France which Khon Kaen University got the license) was used to analyze data and derive both of sensory and mood perceptual maps.

Results and Discussions

Screening beverage samples for fatigue reduction results

After the marketed beverage products were ranked and calculated frequencies, the results showed that the six most frequently consumed or preferred to use beverages drunk for increasing energy were identified by most of fifty consumer panels. The drinks were carbonated soft drink (Coca Cola's brand), bottled drinking water (Nestle's brand), electrolyte drink (Sponsor's brand), orange juice (Tipco's brand), caffeine drink (M150's brand) and green tea beverage (Oishi's brand).

In addition, the moods that most of fifty consumer panels anticipated to have after the consumption of beverages with energy increasing capabilities, which were listed in the questionnaire, were chosen into first three orders. The first three moods most preferred after drinking the beverages were refreshing, un-sleepy and active.

Then, both ranking data sets (beverages and preferred moods) were arranged using cross tabulation by considering the first rank order. The results showed that the first six marketed beverage product samples were also consumed for refreshment, counteract sleepiness and active purposes. Thus these first six marketed beverage product samples were used in the investigation of the drink sensory characteristics.

Results of the questionnaire also showed consumer attitudes on fruit juice beverages. The attitude was found in favor of using fruit juice for energy increasing. Table 2 summarized that 70 % consumer panels mostly consume drinking water when they feel losing energy after they are done exercising. Fruit juice usage in regards to energy increasing, after exercising, was accepted by 100%

Table 2. The opinions on energy drinks (N=50)

Questions	Percentage (%)
1. When you exercise, describe any feelings that you may have?	Powerless, Tired/weak Muscles feel sore
2. How often do these feelings occur to you while you exercise?	
1-2 days per week	22.0
3-4 days per week	42.0
5-6 days per week	4.0
Everyday	12.0
I'm not sure	-
Not at all	28.0
After exercise	-
3. What is the level of these feelings that you would experience normally during exercise?	20.0
A little bit of fatigue	58.0
A moderate amount of fatigue	22.0
Very large	
4. Normally how do you reduce these feelings after exercise?	
Drinking	70
Other (Rest and take a shower)	30
your opinion, does drinking a beverage help increase energy after exercise?	
No	2.0
Yes	98.0
6. How often do you use a beverage to reduce fatigue after exercise?	
Not at all	2.0
1-2 days per week	12.0
3-4 days per week	20.0
5-6 days per week	4.0
Everyday	52.0
After exercise	-
I'm not sure	10.0
7 What types of beverage you mostly drink when you are losing energy after you are done exercising?	78.0
Drinking water	22.0
Others (Caffeine drinks, carbonate water and electrolyte water)	
8. After you are done exercising and you take a drink, describe how you feel?	Refreshing Un-sleepy Active
9. Do you think fruit juice drink would help increase energy?	
No	-
Yes	100
I'm not sure	-
10. If there is information that some fruits consists of several nutrients which can help increase human energy after exercise, would you drink a beverage made from that fruit?	92.0
Yes	8.0
No	-
I'm not sure	
11. Fortification of some nutrients into fruit juice drink which effect on energizing mood increase	58
Agree	42
Disagree	
your opinion, what are important characteristics of fruit juice drink you would use after exercise?	
Appearance	70.0
No color	30.0
Color	84.0
Transparent	16.0
Clearness	12.0
Cloudy	66.0
Sour	22.0
Not sour	4.0
A little sour	76.0
Some what sour	16.0
Sweet	4.0
Not sweet	
A little sweet	
Some what sweet	
Very sweet	

Table 3. Sensory characteristic loadings on main GPA dimensions

Sensory characteristics	F1	F2	F3	F4
Yellow colour	-0.66			
Brown colour		0.81		
Colour intensity		0.72		
Turbidity	-0.95			
Flesh quantity	-0.92			
Bubble quantity			0.80	
Natural odour		-0.76		
Fruity flavour	-0.82			
Floral flavour				-0.84
Sweetness				-0.72
Sourness			-0.77	
Salty			-0.58	
Flavor intensity	-0.77			
Sparkling		0.88		
Mouth feel		0.65		
Moist left over throat			-0.60	
Overall liking		0.64		
Percent of variance (%)	36.30	24.69	14.46	7.83
Cumulative percent (%)	36.30	60.99	75.45	83.28

beverages help increase energy and/or consume to prolong exercise. Green tea and orange juice were reported by Tanaka *et al*. (2008) and Haworth (1998) to also increase energy. Thus six beverages were selected to use as energized testing beverages in this study.

Furthermore, the result of the questionnaire survey indicated that the 100 percentage of consumer panels accepted fruit juices for increasing energy after exercising. It is interesting that 92% of consumer panels chose to drink fruit juice drinks for increasing energy after exercising. There were several reports which indicated that athletes who are losing energy usually consumed bananas for boosting energy before and during exercising (Brouns, 2002; Karunamit, 2002; Johnson, 2005). Thus, fruit juice drink was also selected for increasing energy due to its energy regaining aspects.

The sensory characteristics preferred in the energy drinks that were agreed upon by consumer panels, are transparency and minor sweetness (or non-sweetness) in taste. A study by Labbe *et al*. (2007) showed that the least refreshing drinks were the sweetest drinks according to consumers. Parkinson et al. (1996) offered that the intake of carbohydrates (in the form of sweets) was found to increase losing energy.

These results show that it is possible for fruit juice drink to be taken for increasing energy in Thai market. The sensory characteristics preferred in the fruit juice drink agreed upon by consumer panels are transparency, minor sweetness or a non-sweet taste.

Investigating relationships between sensory characteristics of the beverages and preferred moods after drinking results

The results from RGM showed a list of sixteen sensory characteristics which were highly present in

consumer panels. It was also true for fruit juice which consists of several nutrients which can help reduce human fatigue after exercise as well (92%).

Most of the consumer panels (78%) preferred to consume drinking water when they felt losing energy after exercising. This result is in line with a study by Zellner and Durlach (2002) which showed that 86 American students (90% of respondents) frequently drank drinking water for refreshment. In addition, 22% of consumer panels also chose to consume caffeine drinks, carbonated water and electrolyte drink to increase their energy. Lorist and Tops (2003), Taewoong *et al*. (2006) and Ostojic and Mazic (2002) also reported that caffeine, carbonated and electrolyte

Table 4. Preferred mood loadings on GPA main dimensions

Preferred moods	F1	F2
Refreshing		0.97
Un-sleepy		0.86
Energizing	-0.73	0.79
Alertness		0.95
Quenching		0.88
Good mood		0.59
Relaxing		0.80
Revitalizing		0.98
Active		0.75
Clearheaded		0.95
Overall liking		0.93
Percent of variance (%)	30.73	23.30
Cumulative percent (%)	30.73	54.03

Figure 1. Sensory perceptual maps of six beverage samples

Figure 2. Perceptual maps of preferred mood of six beverage samples

six beverages that consumer panels normally drink to increase their energy. Then GPA showed sixteen sensory characteristics of beverages (Table 3) that are associated with the main GPA dimensions (Fs). Key sensory characteristics within Factor 2 are mostly related to overall liking. This means that when color intensity, sparkling level, natural odour loss and mouth feel of beverages were increased, overall liking also increased.

FFI also delivered a list of ten preferred moods after drinking the beverages. Most of the preferred moods were similar to the list of moods that occurred after drinking caffeine beverages, such as revitalization, quenching of thirst, energy, relaxation and clear-headedness (Smit and Rogers, 2002).

In addition, the GPA showed ten moods which consumer panels preferred after drinking (Table 4) are associated with the main GPA dimensions (Fs). All preferred moods are positively related to overall liking. It means that when the preferred mood levels were increased, overall liking was also increased.

From above results, it can be concluded that increasing of color intensity, sparkling level, natural odour loss and mouth feel of beverages affected on increasing overall liking and all preferred mood levels.

GPA produces the consensus configurations which are interpreted by correlating each individual's set of sensory characteristics with the dimensions of these configurations. The first bi-plots (Figure 1) are called sensory perceptual maps. The first two dimensions (on axes F1 and F2) of the sensory characteristics represent 60.99% of the initial variability of the data. Along the sensory perceptual map, the vector of overall liking points in association with moistness left over in the throat which is highly presented in carbonated soft drink and caffeine drink.

The second bi-plots (Figure 2) are perceptual maps on preferred moods. The first two dimensions (on axes F1 and F2) of preferred moods represent 54.03% of the initial variability of the data. Along the preferred mood-perceptual maps, the vector of
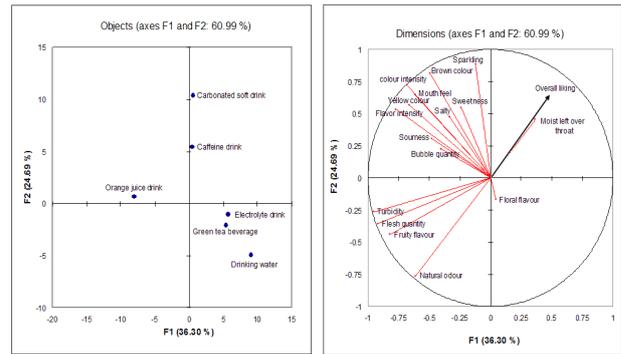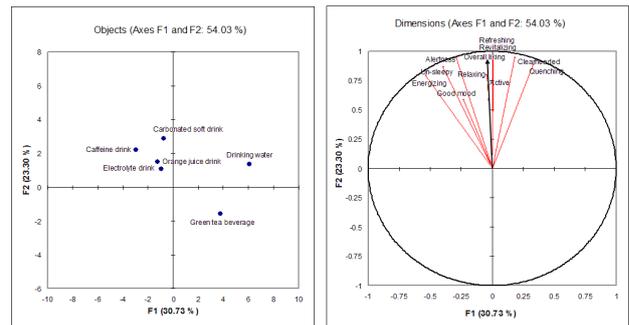
overall liking points to all preferred moods is highly present in the carbonated water.

Thus, carbonated water and caffeine drinks were flavored most ($p < 0.05$) for fatigue reduction purpose due to moistness left over in the throat as well as its transparent and mild fruity odor and artificial flavour characteristics. Both drinks also delivered higher level of all preferred moods than other drinks [these outcomes are different to the results derived by questionnaire survey methods. Most of the consumer panels preferred to consume drinking water when they felt losing energy after exercising. This result may occur due the fact that there was no sample presentation during the questionnaire survey, thus consumers may think about the most familiar beverage which was drinking water]. Thus, the sensory characteristics of both drinks were considered for improvement of fruit juice drink samples used for increasing energy study.

Conclusions

From the results of classifying and ranking, some marketed beverage products in Thailand consumed after exercising for increasing energy were ranked in a group of six beverage products. They were carbonated water, drinking water, electrolyte drink, orange juice, caffeine drink and green tea, ranked first to sixth respectively. These outcomes are similar to the results derived by questionnaire survey methods. The directions of overall liking (followed

the analysis method of Kleij and Musters (2003) from the both perceptual maps are used to describe which beverages responded the most to preferred moods. It also provided the sensory characteristics of the selected beverages. Apparently, carbonated water and caffeine drinks contributed to high levels of the most preferred moods such as relaxation, activeness, revitalization, refreshment, energy and alertness more than other drinks. The two drinks were flavored most due to their sensory characteristic of 'moistness left in the throat' and 'transparency'. Thus, the trend to develop the fruit juice drink for increasing energy should follow the positive sensory characteristics of both beverages as a guideline. The advantage of perceptual maps is consumer panels give detailed evaluations across many attributes for each product which provide an explicit description of the dimension. However for the disadvantage, brand evaluations are limited to the attributes rated by consumer panels.

References

Bansiddhi, K. 2004. Current status and prospects of banana R&D in Thailand. Advancing Banana and Plantain R&D in Asia and the Pacific 12: 111-115.

Brouns, F. 2002. Essentials of sports nutrition. 2nd edn. Chichester: Wiley.

Davis, J. M., Zhao, Z., Stock, H. S., Mehl, K. A., Buggy, J. and Hand, G. A. 2003. CNS effects of caffeine and adenosine on fatigue. American Journal of Physiology Regulatory Integrative and Comparative Physiology 284: R399-R404.

Gains, N. 1994. The repertory grid approach. In Measurement of Food Preferences. pp. 227-252 (MacFie, H. J. H. and Thomson, D. M. H., eds). Glasgow: Blackie A&P

Haworth, N. 1998. Fatigue and Fatigue Research: The Australian Experience. 7th Biennial Australasian Traffic Education Conference, speed, alcohol, fatigue, effects, Brisbane.

Hayes, B. E. 1998. Measuring customer satisfaction, 2nd Edition USA: QSQC press.

Hengsawasdi, D. 2002. Fruit eating for health. Agricultural Magazine 75(5): 39-44.

Howell, A. 2005. Health matters: Flu Fighters in Your Fridge, Health wise USA: Illinois Wesleyan University.

Jaeger, J. 2007. XLSTAT-MX/GPA. France: Addinsoft.

Johnson, D. 2005. Is vitamine need or not? Achiveve 5(59): 46-48.

Karcher, M. 2003. Potassium-rich foods deter muscle cramps. The Ohio State University, Ohio Agricultural Research and Development Center: May 4.

Karunamit, S. 2002. Effect of Banana Consuming on Maximum Oxygen Uptake and Blood Chemical Substance Related to Aerobic Capacity. Master of Science (Sports science) Thesis, Chieng Mai: Graduate School, Chieng Mai University.

Khajarern, K. 2001. Application of Sensory Perceptual and Contextual Mapping for Generating New Beer Product Ideas, Master of Science Thesis in Food Technology, Graduate School, Khon Kaen University.

Kleij, F. T. and Musters, P. A. D. 2003. Text analysis of open-ended survey responses: A complementary approach to preference mapping. Food Quality and Preference 14: 43–52.

Labbe, D., Gilbert, F., Antille, N. and Martin, N. 2007. Sensory determinants of refreshing. Food Quality and Preference. NA.

Lorist, M. M. and Tops, M. 2003. Caffeine, fatigue, and cognition. Brain Cognition 53: 82–94.

Lyman, B. 1989. A psychology of food, New York: Van Nostrand Reinhold.

Ostojic S. M. and Mazic, S. 2002. Effects of a carbohydrate-electrolyte drink on specific soccer tests and performance. Journal of Sports Science and Medicine 1: 47-53.

Parkinson, B., Totterdell, P., Briner, R. B. and Reynolds, S. 1996. Changing Moods. England: Addison Wesley Longman.

Pridemore, W. A., Damphousse, K. R. and Moore, R. K. 2005. Obtaining sensitive information from a wary population: A comparison of telephone and face-to-face surveys of welfare recipients in the United States. Social Science and Medicine 61: 976-984.

Public Division, Ministry of Public Health, Thailand and Tourism Authority of Thailand. 2005. Fruits of Thailand. [Serial online] [2005] Available from: *URL: www.thailandguidebook.com/fruit.html.*

Resurreccion, A. V. A. 1998. Consumer Sensory Testing for Product Development. Maryland: Aspen Publishers, Inc.

Rogers, P. J., Green, M. W. and Edwards, S. 1994. Nutritional influences on mood and cognitive performance: Their measurement and relevance to food acceptance. In Measurement of Food Preferences. pp. 227-252 (MacFie, H. J. H. and Thomson, D. M. H., eds). Glasgow: Blackie A&P.

Sanz, M. L., Villamiel, M. and Martinez-Castro, I. 2004. Inositols and carbohydrates in different fresh fruit juices. Food Chemistry 87: 325–328.

Scriven, F. M., Gains, N., Green, S. R. and Thomson, D. M. H. 1989. A contextual evaluation of alcoholic beverages using the repertory grid method. International Journal of Food Science and Technology 24: 173–182.

Shiebler, J. 2004. Vegetable and fruit juice for good health. Food and Health 17(111): 27-31.

Smit, H. J. and Rogers, P. J. 2000. Effects of low doses of caffeine on cognitive performance, mood and thirst in low and higher caffeine consumers. Psychopharmacology 152(2): 167-173.

Smit, H. J. and Rogers, P. J. 2002. Effects of 'energy' drinks on mood and mental performance: Critical methodology. Food Quality and Preference 13: 317-326.

Taewoong, O., Mitsuru, H., Kazuyuki, K., Chiyoko, U., Isao, M., Shizuo, S., Ikuo, M. and Hiromichi, M. 2006.

Effects of carbonated and noncarbonated beverage intakes in response to prolonged cycle ergometer exercise. Japanese Journal of Physical Fitness and Sports Medicine 55: 205-208.

Tanaka, M., Baba, Y., Kataoka, Y., Kinbara, N., Sagesaka, Y. M., Kakuda, T. and Watanabe, Y. 2008. Effects of (-)-epigallocatechin gallate in liver of an animal model of combined (physical and mental) fatigue. Nutrition 24(6): 599-603.

Templeman, J. F. 2005. Mangosteen research introduction, [serial online] Available from: *URL: www. ResearchMangosteen.com*.

Thanalertkul, S. 2005. Guide to vitamins, minerals and supplements. Bangkok: Reader's digest (Thailand).

Turner, L. 2001. More power by fruit juices. Food and Health 14(94): 66-70.

Zellner, D. A. and Durlach, P. 2002. What is refreshing? An investigation of the color and other sensory attributes of refreshing foods and beverages. Appetite 39: 185–186.