Effects of banana drinks taken for fatigue reduction

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Abstract: Levels of fatigue may relate to motives of food or drink choice. This study aimed to test the banana drink effects in comparison to drinking water on fatigue reduction. The Labeled Magnitude Fatigue Scale (LMFS) was applied with Thai subjects (n=45). Scale reliability and validity in measuring fatigue were tested by internal consistency and physiological changes, respectively. The results showed that after drinking the banana drinks, fatigue mean scores were reduced more than those obtained from drinking water ($p < 0.01$). When the subjects were classified into high and low fatigue groups, there was no beverage effect on fatigue reduction in 'low fatigue group'. However, the banana drinks showed impact on fatigue reduction more than drinking water did in 'high fatigue group'. This discovery should be beneficial for segmenting consumers in beverage markets. The LMFS shows high reliability (α range between 0.89-0.90) and high validity when related with heart rate (r range between 0.62-0.65).

Keywords: Fatigue, banana drinks, labeled magnitude scale, scale reliability and validity, physiological changes

Introduction

Fatigue is a mood or temporary feeling (O'Conner, 2004). Moods normally, last for hours, but they can range in duration from minutes to weeks (Parkinson *et al*., 1996). The fatigue refers to the feeling of having a decreased ability to complete physical or mental activities (Stahl, 2002).

The interrelationships between food, mood and behaviour were described by Rogers (1996) in this way; the effects of food on mood are mediated by physiological mechanisms and may feed back to affect food preference and consumption. The beneficial effects of mood are believed to affect food and drink choice (Smit and Rogers, 2002). There has been substantial interest in the effects of food or drink on mood (Christensen, 2001; Appleton and Rogers, 2004). There are related studies such as, the effects of thiamine supplementation on fatigue by Suzuki and Itokawa (1996) and the effects of energy drinks on mood by Smit and Rogers (2002). If an individual believes that consumption of a particular food or drink has advantageous effects, reasonable they should be more willing to pick out that product and when a product contains unpleasing effects then that should lead to the product's evasion (Roger *et al*., 1994). Identifying the effects of food or drink on mood may be of important commercial value in product development and marketing.

People usually take drugs or artificial reagents when they have a feeling of fatigue (Pichainarong *et al*., 2004). These reagents relate to several health problems such as drug allergies, neurosis or illness (Chatbunchachai, 2001). This is an important reason to treat fatigue with food or drink for the avoidance of drug usage (Thanalertkul, 2005). Hence, this research focuses on reducing fatigue by drinking banana drinks as an alternative to drugs. 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.

There is a relationship between food acceptance, food choice as well as food intake and the food's effects on fatigue reduction (Rogers, 1996). This research aimed to test this relationship and determined

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whether the banana drinks can reduce fatigue, increase the product's acceptance, stimulate consumer usage and a willingness to purchase the product.

Banana drink from banana syrup (a research product developed by Cheamsawat, King Mongkut's University of Technology Thonburi, Thailand in 2003) was processed by ultra-filtration and followed by vacuum evaporation of the extracted banana juice. The process was done using a low temperature in order to maintain the important nutrients and vitamins in the original banana which help to reduce fatigue. The banana drink was selected for this study because it is an important source of vitamin B (Cheamsawat, 2003) especially thiamine, which has an effect on fatigue reduction (Early and Carlson, 1969; Suzuki and Itokawa, 1996; Appleton and Rogers, 2004). Cheamsawat (2003) suggested preparing the banana drink by diluting the banana syrup with drinking water to obtain the appropriate concentration for the drink and to avoid an overly-sweet taste. Since the dilution of the samples would decrease the quantity of thiamine, thiamine fortification in the banana drink may be necessary to replace the decrease of thiamine during dilution.

In the World Health Organization (WHO) guidelines on food fortification with micronutrients, thiamine toxicity from over dosage is not a concern. The United States Food and Nutrition Board has also not yet defined the upper intake limits of thiamine (Allen *et al*., 2006). However, Recommended Dietary Intakes (RDIs) by the Thailand Food and Drug Administration; Thai FDA (1997) of thiamine for Thai adults is 1.2 mg per day. The median intake of thiamine from food in the United States is approximately 2 mg per day (Kumar, 2007). Simpattananont (1995) suggested that adults should take 0.5 mg of thiamine per 1000 Kcal per day but athletes need to increase it by two more mg per day since they require more energy. Thus the quantity of thiamine fortification in the banana drink samples would need to be about 2 mg in order to substitute the thiamine lessening after diluting the syrup.

Objectives

1. To test the effects of the banana drinks in comparison to bottled drinking water on fatigue reduction and to explore relationships between the fatigue levels, consumer acceptance and WTP scores.
2. To evaluate reliability and validity of the LMFS based on the effects of the banana drinks and bottled drinking water on fatigue reduction.

Materials and Methods

Samples

There were three samples for this study. They were;

(1) Banana drink A: An eight degree Brix recommended sport drink (Yunchalad, 1993) prepared from 70 degree Brix banana syrup,

(2) Banana drink B: Banana drink A was fortified with thiamine hydrochloride (Allen *et al*., 2006) to reach a total of 2 mg thiamine in one serving portion, and

(3) Bottled spring drinking water was used as a controlled sample.

In a taste test, only for banana drink samples, when served, were masked with an equal intensity of artificial banana flavour (Best Odor Co., Ltd., Thailand -commercial grade) (0.05% of 250 ml) before serving. All samples were served in a transparent plastic container with a lid cover and encoded with random three digit numbers. The temperature of the samples was set at 4 ^{o}C before serving (Brouns and Kovacs, 1997). The serving quantity was 250 ml (equivalent to a standard canned- energy drink tested by Alford *et al*. (2001) and was a sample of the energy drinks tested for fatigue reduction in Smit and Rogers (2002).

Subjects

Forty-five Thai group subjects (Seaton *et al*., 2005), of which 32 females (mean age = 20.9 ± 2.0, mean BMI = 20.7 ± 0.8 kg/m^2) and 13 males (mean age = 21.9 ± 2.5, mean BMI = 22.1 ± 1.4 kg/m^2) were recruited using convenient sampling at Khon Kaen University, in an arranged room for aerobic dance exercising at the Faculty of Technology, Khon Kaen University, Thailand.

The individual subjects were of good health, based on an exercise demonstration and their recorded health interview, and were willing to participate in this study. Signed consent forms were obtained from all suitable volunteers who took part in the study. The study protocol was approved by the Human Research Ethics Committee of Khon Kaen University, Thailand.

Fatigue questionnaire using LMFS

Subjects used the labeled magnitude fatigue scale (LMFS) as a method for reporting their fatigue perceptions or symptoms (Khajarern, 2009). They were asked to report their response intensity, regardless of 13 fatigue items, to each session. Each subject was asked to rate the perceived intensity of each phase along the vertical LM scale.

Experimental design

45 participants were required to report their fatigue themselves before exercising using the LMFS [in order to monitor perceived overall fatigue, the 3 conclusive fatigue items such as overall, physical and mental fatigues were also added as extra questions after the fatigue scales]. They then exercised (aerobic dance using a video) for 30 minutes and reported their fatigue again, after exercising, using the LMFS [this exercise was set to generate the test subjects' exhaustion (American Diabetes Association, 1996). The main objective of the exercise was to induce a state of mild fatigue (Smit and Rogers, 2002).]. Next, they were asked to drink 250 ml of a sample and immediately report their fatigue after drinking the sample, and also after resting for 30, 60 and 90 minutes [as suggested in the clinical fatigue measurement by Suzuki and Itokawa (1996) and Merrill *et al*. (2002)]. Then the participants came back for a replicated test after a few days, during the same week (each subject was tested twice a week, for 3 weeks). The Randomized Complete Block Design (RCBD) was assigned for arranging the test replications (Meilgaard *et al*., 1999).

All subjects were asked to avoid consuming food and drink before and during each test. They were allowed to read, relax, or talk with one another during rest. The aerobic dance exercising rooms were arranged to include facilities for the test subjects such as an aerobic dance area, a relaxation zone, video player, projector and projector screen, air conditioning was used to control the room temperature at 25^{o}C.

To test the criterion-related validity of scale, physiological changes such as heart rate and blood pressure (systolic and diastolic) were gauged each time the subject was about to finish reporting their fatigue using the LMFS. A digital wrist meter [Omron HEM-629 Portable Wrist Blood Pressure Monitor, Omron Healthcare, Inc. Illinois, USA] was given to each individual subject with instructions to measure and self-record their heart rate and blood pressures after they had just finished scoring their self-report scale.

Liking and willingness to pay (WTP) tests

After finishing drinking 250 ml of a sample (one sample per session), subjects were asked to rate their liking and WTP for the drink by indicating the degree of liking and WTP for each sample on the Labeled Affective Magnitude Scale (LAMS) and Labeled Magnitude Scale (LMS) for WTP (Khajarern, 2009). The scale consisted of a vertical line 100 mm in length and eight verbal phrases stating their preference and WTP levels on the vertical line for the eight positions according to their own perceptions and judgment; *'like or WTP, the strongest imaginable'* (100 mm), *'like or WTP, extremely'* (89.7 mm), *'like or WTP, very much'* (75.7 mm), *'moderately like or WTP'* (52.9 mm), *'slightly like or WTP'* (30.7 mm), *'dislike or no WTP'* (14.8 mm), *'dislike very much or very much no WTP'* (7.1 mm) and *'extremely dislike or absolutely no WTP'* (0 mm). In addition, subjects were also asked to rate their willingness to purchase the drink by answering the question *'How much money would you be willing to pay for the drink?'* There were 5 choices of 10, 15, 20, 25 and 30 Thai Baht for the WTP test according to marketed prices on similar energy drink groups.

Data analysis

Fatigue scores derived from the subjects, during the six testing situations were analyzed by various statistical parameters. Descriptive statistics of the individual's demographic data were also summarized for fatigue, liking and WTP. Cronbach's alpha and Pearson's correlation coefficients of the 13-item LMFS for each sample was analyzed for internal consistency (Lee *et al*., 1991) and test-retest reliability using SPSS/PC for Windows Version 16.0 developed by SPSS Inc., Chicaco, USA in 2007. The test-retest reliability was used as an estimate of the scale's reproducibility over time, assuming that no change in measuring conditions had taken place (Horemans *et al*., 2004). Multiple correlation coefficients between fatigue levels measured by the LMFS and physiological change measurements reveal the criterion related validity of the scales (Dagneli *et al*., 2006). The level of significance for all statistical analysis was set at 0.05. For this significance level ($p < 0.05$), Okuyama *et al*. (2000) also used in their fatigue research.

Results and Discussions

Figures 1 show the results of the effects of the beverages on the mean scores of fatigue, blood pressure and heart rate in order to describe the level of fatigue measured by the LMFS during each session of the beverage test, The levels of fatigue, blood pressure and heart rate markedly increased transiently after exercising then decreased immediately after drinking each beverage sample and after resting 30, 60 and 90 minutes.

Fatigue scores measured with the LMFS, after drinking the banana drinks and drinking water in each session were compared in Figure 1. The highest possible scores on both scales are 10. The mean fatigue scores after exercising from each treatment (4.8 ± 1.2 from drinking water, 4.8 ± 2.5 from banana drink A, and 4.9 ± 2.5 from banana drink B) were not significantly different ($p > 0.05$). The fatigue after exercising was in the moderate level. After drinking each beverage, the mean fatigue scores reduced to 4.5 ± 1.1 (drinking water), 3.9 ± 1.9 (banana drink A), and 3.2 ± 2.0 (banana drink B). The mean fatigue scores of the test subjects before the test and after drinking, were significantly different ($p < 0.05$) on each beverage test (t = 9.87 from drinking water, t = 10.3 from banana drink A, t = 12.1 from banana drink B). This means that the three beverage samples used in this study reduced fatigue. However, the fatigue mean scores after drinking the banana drinks A and B were not significantly different (t = 1.21, $p > 0.05$). The fatigue mean scores after drinking banana drink A decreased more than the drinking water (t = 2.30, $p < 0.05$) and the fatigue mean scores after drinking banana drink B also decreased more than the drinking water (t = 2.97; $p < 0.05$). Suzuki and Itokawa (1996), showed the effects of 100 mg of thiamine supplementation on exercise-induced fatigue reduction. Overall fatigue before exercising was in the *'slightly'* level then up to *'fairly'* level after exercising. After taking 100 mg thiamine, the overall fatigue was reduced to the *'moderate'* level and after 60 minutes of rest, it was reduced to *'slightly'* level.

The mean fatigue scores were related to physiological changes such as blood pressure (r range between 0.43-0.47) and heart rate (r range between 0.62-0.65). The mean blood pressure was compared in each session of banana drinks and drinking water tests (Figure 1). The mean blood pressure after exercising from each treatment was not significantly different (111.5 ± 9.2 from the drinking water, 112 ± 9.6 from banana drink A and 111.3 ± 10.4 from banana drink B, $p > 0.05$). After drinking each beverage, the blood pressure mean scores reduced to 105.8 ± 9.2 (drinking water), 107.7 ± 8.9 (banana drink A), and 107.6 ± 10.4 (banana drink B). The mean blood pressure before testing and after drinking were significantly different in each beverage test (t = 12.8 for the drinking water, t = 10.7 for banana drink A and t = 9.3 for banana drink B, $p < 0.05$). Therefore, it seems that the beverages used in this study helped to reduce the blood pressure. The mean blood pressure after drinking banana drinks A and B were not different (t = 0.25, $p > 0.05$), and the reduction was less than the drinking water (t = -2.35 for banana drink A and the drinking water and t = -1.93 for banana drink B and the drinking water, $p < 0.05$).

According to the blood pressure chart presented by Vaughn (2008), the blood pressure after exercising were in the range of *'normal blood pressure'* (systolic; 110-120). After drinking, the blood pressure decreased to the range of *'blood pressure after strenuous exercise'* (systolic; 100-110). The blood pressure decreased even more to the range of *'low-normal blood pressure'* (systolic; 90-100) after drinking either of the banana drinks and resting for 90 minutes Vaughn (2008) indicated that *'low-normal blood pressure'* is the normal level of blood pressure for athletes. Although the blood pressure after drinking water decreased more than after drinking the banana drinks, the blood pressure did not decrease to the range of *'low normal blood pressure'*.

The heart rate mean scores after drinking both the banana drinks and the drinking water were compared in each session (Figure 1). The heart rate mean scores after exercising during each treatment were not significantly different ($p > 0.05$) (101.1 ± 15.3 for the drinking water, 104.4 ± 13.7 for banana drink A and 103.3 ± 13.2 for banana drink B). After drinking each beverage, heart rate mean scores reduced to 86.7 ± 12.1 (drinking water), 91.0 ± 10.2 (banana drink A), and 89.6 ± 1.0 (banana drink B).

The heart rate mean scores before the test and after drinking each beverage were significantly different ($p < 0.05$) (t = 16.86 for the drinking water, t = 16.19 for banana drink A and t = 17.7 for banana drink B, $p < 0.05$). The mean heart rate scores after drinking banana drinks A and B were significantly different (t = 1.49, $p < 0.05$), and reduced less than the drinking water (t = -2.69 for banana drink A and the drinking water and t = -1.62 for banana drink B and the drinking water, $p < 0.05$). This result can be explained by stating that the heart rate after drinking banana drink B was lower than banana drink A but the heart rate after drinking either of the banana drink was higher than the drinking water.

To understand the effects of beverages on fatigue reduction clearly, the subject group fatigue data was separated into high and low fatigue groups (Forton *et al.*, 2004). The average of the individual scores of all items was used to classify the fatigue group ('low fatigue group', range of fatigue score before test between 2-3 scores; 'high fatigue group', range of fatigue score between 4-5 scores). The wanted mood items were adjusted using reverse scoring (De Vellis, 1991) before summarizing. Then the sum scores of the individual subjects were sorted from minimum to maximum and then the scores were separated into three ranges. The subjects who had the fatigue sum scores in the lower range were defined as *'low fatigue subjects'* and, on the other hand, the subjects who had the fatigue sum scores in the upper range were

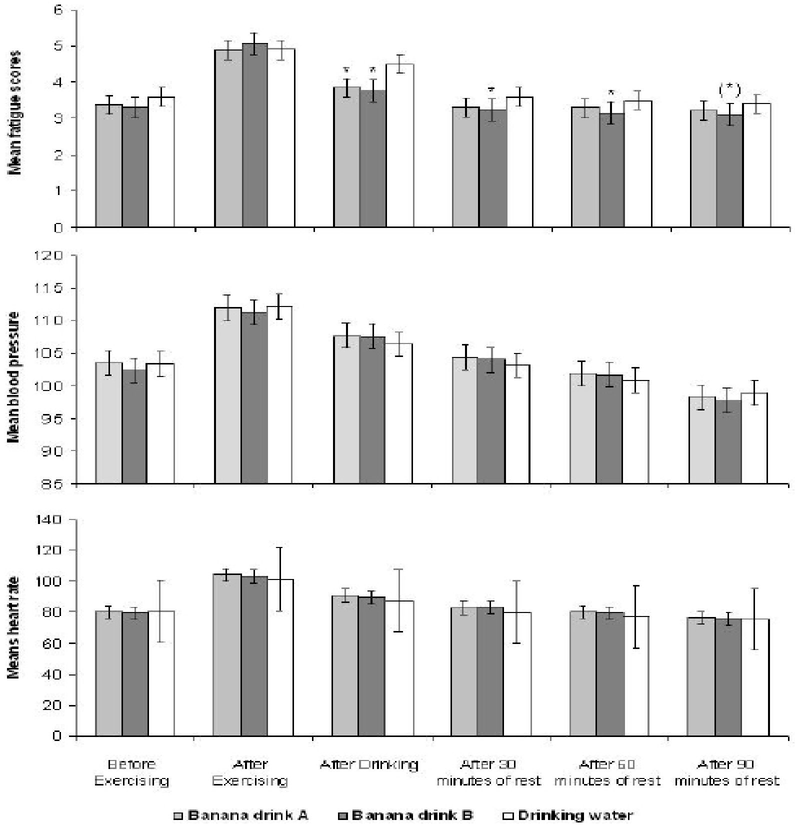

Figure 1. Means of the fatigue scores, blood pressure and heart rate measured during six testing situations with the three beverage samples
* = significantly different from drinking water, $p < 0.05$;
(*) = different from drinking water ($t = -1.86$, $p < 0.065$)

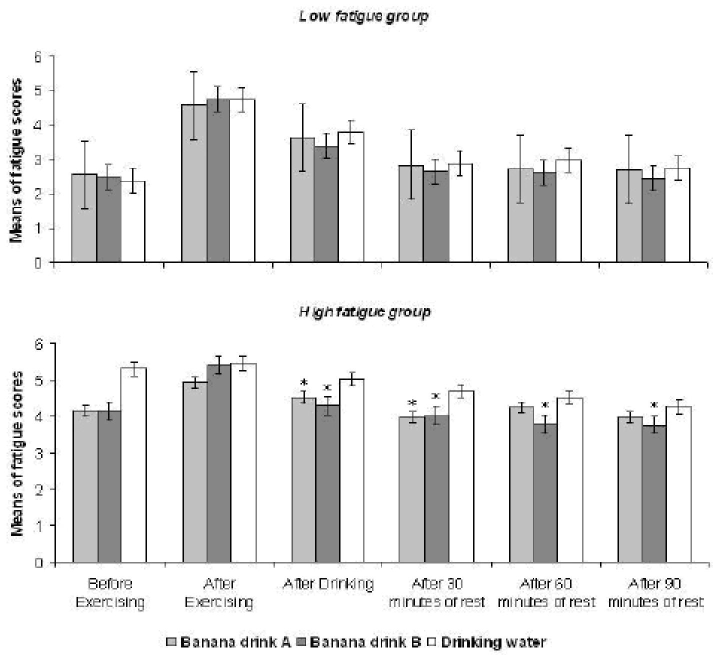

Figure 2. means of fatigue scores measured during the six testing situations with the three beverage samples for the low and high fatigue groups
(* = significantly different from drinking water)

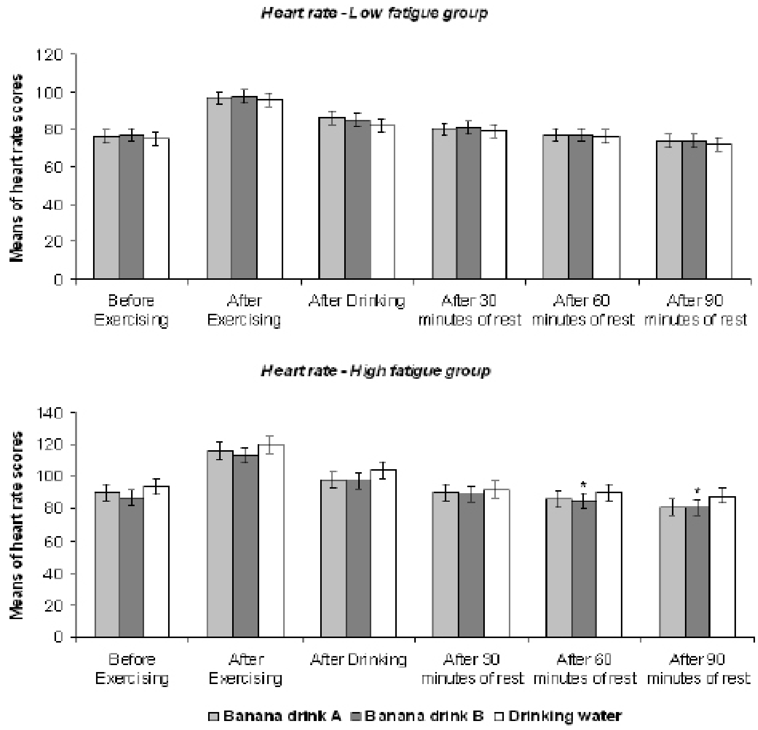

Figure 3. Means of heart rate scores measured during the six testing situations with the three beverage samples for the low and high fatigue groups
(* = significantly different from drinking water)

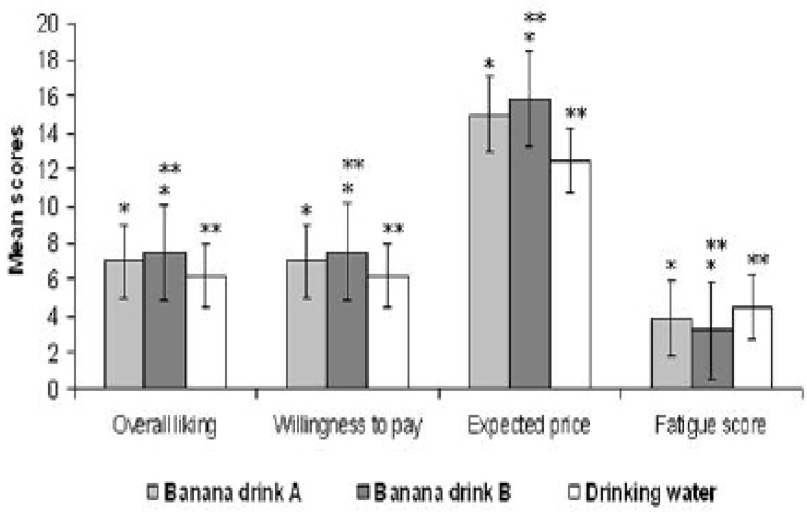

Figure 4. Mean scores on “Overall liking”, “Willingness to pay”, “Expected price” and “Fatigue score”
* = significantly different from drinking water, $p < 0.05$
** = significantly different from banana drink A; $p < 0.05$

Table 1. Internal consistency reliability of the 13-item LMFS using α for each sample test

Scales	Total item Cronbach's alpha of scales					
	Before exercising	**After exercising**	**After drinking**	**30 minutes of rest**	**60 minutes of rest**	**90 minutes of rest**
Drinking water	0.89	0.85	0.83	0.87	0.85	0.86
Banana drink A	0.82	0.87	0.82	0.84	0.86	0.83
Banana drink B	0.82	0.84	0.84	0.81	0.79	0.79

Each total item α was calculated throughout the six testing situations:
Total item α = 0.85 (drinking water), 0.84 (banana drink A) and 0.85 (banana drink B)

Table 2. Test-retest correlation coefficient of the 13-item LMSF for each sample test

Scales	Pearson's correlation coefficient between replications					
	Before exercising	**After exercising**	**After drinking**	**30 minutes of rest**	**60 minutes of rest**	**90 minutes of rest**
Drinking water	0.74**	0.68**	0.72**	0.79**	0.75**	0.83**
Banana drink A	0.72**	0.89**	0.85**	0.82**	0.73**	0.84**
Banana drink B	0.75**	0.75**	0.79**	0.74**	0.71**	0.71**

The total item correlations between replications, r = 0.77 (drinking water), 0.85 (banana drink A) and 0.79 (banana drink B)
** Correlation is highly significant at the 0.01 level (2-tailed).

Table 3. The multiple correlation coefficients between each physiological factor and fatigue scores of all items from LMFS for Thai consumer panels.

Drinking water		Banana drink A		Banana drink B	
Blood pressure	**Heart rate**	**Blood pressure**	**Heart rate**	**Blood pressure**	**Heart rate**
0.47	0.62	0.46	0.66	0.43	0.65

defined as *'high fatigue subjects'*. The subjects whose fatigue scores were in the middle range (classified as *'normal subjects'*) were not included in the statistical tests here, so that the differences between the two extreme fatigue groups would be revealed.

The individual fatigue scores of the low and high fatigue groups were averaged and compared with all beverage tests in each session (Figure 2). The beverage samples did not affect fatigue reduction differently in the *'low fatigue group'*. The two banana drinks had a greater impact on fatigue reduction than the drinking water in the *'high fatigue group'*. The average heart rate scores of the low and high fatigue groups were also shown the same result (Figure 3). This discovery can be beneficial for segmenting consumers in beverage markets, for this example, consumers in the low fatigue group can reduce their fatigue by taking only drinking water but consumers in the high fatigue group should drink the developed beverages for their fatigue reduction.

Reliability and validity of scale

To test the reliability of the LMFS for fatigue measurement, total-item internal consistency (Cronbach's alpha) was used. The results showed that the total-item Cronbach's alpha of the scale when testing with the drinking water, banana drink A and B were not different (α = 0.85, 0.84 and 0.85, respectively) (Table 1). These results indicate that the total-item internal consistency of the scale was high (George, Mallery, 2003; Glaim, Glaim, 2003 stated that the range of α between 0.8 - 0.9 was high).

Another parameter test for scale reliability used in this study is the test-retest reliability which refers to measurement of the scale stability over time when the scale was assessed. The test-retest reliability of the LMFS for each beverage test of the two replications during each session was also tested by considering Pearson's correlation coefficient between the two test replications. The results showed the scale stability in high levels (the total item correlations between replications were 0.77 for the drinking water, 0.85 for banana drink A, and 0.79 for banana drink B) (Table 2).

Although the reliability of the scale is important, it is not enough in determining the efficiency of measurements. Therefore, the criterion related validity of the scale was tested and considered together with the reliability test.

In order to test the criterion related validity of the LMFS, the multiple correlation coefficients was used to estimate the relationships between the total fatigue scores of the LMFS and each physiological factor (heart rate and blood pressure levels) for Thai subjects using a multiple linear regression analysis (Hayes, 1998; Tangugsorn *et al*., 1998).

Blood pressure scores related to fatigue itemized scores of the LMFS (r range between 0.43-0.47) highly [$r \geq 0.30$ were considered significant for establishing validity (Emery, 2007)]. In addition, the results of the LMFS measurements also related to the results of heart rate measurement (r range between 0.62-0.66) highly. The multiple correlation coefficients between each physiological factor and fatigue scores of all items from LMFS for Thai consumer panels were high.

Liking and WTP test results

Liking scores measured by the LAMS, after drinking the banana drinks and the drinking water were compared (Figure 4). The liking mean scores after drinking in each treatment were 6.2 ± 1.7 (drinking water), 7.1 ± 1.8 (banana drink A) and 7.4 ± 1.6 (banana drink B). The liking of each drink was in the *'moderately like'* to *'like very much'* levels (the preference levels from the LAMS were given by verbal statements on the vertical line where 5.3-7.6 were *'moderately like'* to *'like very much'*. The liking mean scores of banana drinks A and B were not different (t = -1.40, p > 0.05). The liking mean scores of banana drink A was higher than the drinking water (t = 3.37, p < 0.05) and similar to that of banana drink B (t = 4.91, p < 0.05). Both banana drinks received higher liking scores than the drinking water.

For the willingness to pay scores measured by the LMS for WTP, the WTP mean scores from each treatment were 6.2 ± 1.7 (drinking water), 7.0 ± 1.7 (banana drink A) and 7.3 ± 1.5 (banana drink B). The WTP of each drink was in the *'moderately like'* to *'like very much'* WTP levels (the WTP levels from the LMS for WTP were given by verbal statements on the vertical line where 5.3-7.6 were *'moderately like'* to *'like very much'* WTP). The WTP mean scores of banana drinks A and B were not significantly different (t = -0.99, p > 0.05). The preference mean scores of banana drink A was higher than the drinking water (t = 3.30, p < 0.05), and similar to that of banana drink B (t = 4.51, p < 0.05). Both of the banana drinks received higher WTP mean scores than the drinking water.

The expected mean prices from each treatment were 12.5 ± 3.5 (drinking water), 15.1 ± 4.1 (banana drink A) and 15.8 ± 4.5 (banana drink B). The expected mean prices of banana drinks A and B were not significantly different (t = -1.12, p > 0.05). The expected mean prices of banana drink A was higher than the drinking water ($t = 4.57$, $p < 0.05$), and the same as banana drink B ($t = 5.52$, $p < 0.05$). Both banana drinks received higher expected mean prices than the drinking water.

The hypothesis on the effects of the beverage models on fatigue level, consumer liking, and the WTP scores have now been tested. Figure 3 describes the interrelationships between fatigue, consumer overall liking and the WTP scores after drinking the selected beverages. After drinking each beverage, the fatigue mean scores decreased. Banana drinks A and B seemed to reduce fatigue more than the drinking water, and, were preferred more and had a higher willingness to pay score as well.

The fatigue mean scores show a relationship to the liking mean scores ($r = -0.22$, $p < 0.01$) and WTP ($r = -0.20$, $p < 0.01$) [Emery (2007) interpreted that these levels were in likely to be useful] but no correlation to the expected price. From this negative relationship, it could be assumed that the drink which reduced fatigue more, was preferred more and given a higher WTP score by the test subjects. The expected mean prices of both banana drinks were 15.1 and 15.8 Thai Baht (THB) and were close to the price of Thai marketed canned fruit juice. The expected price of the drinking water was 12.5 THB, and is the same price as the natural imported spring water in the same packing volume (250 ml). The expected prices could be estimated from the subject consumer experiences with the relevant products. However, the fatigue mean scores were not significantly related to the expected price scores.

These results are in line with Rogers *et al.* (1994) and Rogers (1996) that the drinks influence our likings and WTP. The banana drinks reduced fatigue more than the drinking water, thus the subjects preferred and were willing to pay more for them than the drinking water. However, a research of Smit and Rogers (2002) did not support this statement because caffeine drinks (75 mg in 150 ml and in 250 ml of drinking water) which were significantly preferred less by consumers, were found to increase energy more than the drinking water. From this point, not only the sensory quality of the drink should be considered as an important key factor in making a drink choice, but also the effectiveness of the drink's ingredients on fatigue reduction. Since the banana drinks had sweet taste and flavour more than the drinking water, perhaps the subjects preferred them and were willing to pay more for them than the drinking water.

Conclusions

As the banana drinks had a positive effect on fatigue reduction more so than the spring drinking water, when considering the decreasing LMF scores, decreasing blood pressure and decreasing heart rate. The blood pressure levels from this study were compared with the *'normal stage'* on the blood pressure chart presented by Vaughn (2008). After drinking the banana drinks, the systolic and diastolic blood pressures decreased from the range of *'normal blood pressure'* to the range of *'blood pressure after strenuous exercise'* The blood pressure decreased more to the range of *'low normal blood pressure'* after drinking either of the banana drinks and resting for 90 minutes. Although the blood pressure after drinking the water decreased more than after drinking the banana drinks, the blood pressure did not decrease to the range of *'low normal blood pressure'*.

Results from the preference and WTP tests showed that both banana drinks received a higher preference and WTP scores than the spring drinking water. This finding is in line with Rogers's work in 1996 stating interrelationships between diet and behaviour. Since our diet has influences on moods (such as fatigue) and is mediated by physiological mechanisms. The mood can then feed back to influence food preference and consumption. This notion, however, should be considered as a cultural difference since this study was conducted with Thais who are well known for having a sweet taste preference. The banana drinks effectively reduced fatigue more than the drinking water, thus leading to greater product acceptance (in terms of consumer preference and a willingness to pay them). From this point, the effects of banana drinks on fatigue reduction may be of interest for their commercial value in product development and marketing.

The study of the effects of banana drinks on fatigue reduction can be further explored by varying the levels of the drinks sweetness. The 8 degree Brix drink was selected in this study according to Brouns (2002)'s suggestion that it had a suitable sweetness for athletic drinks. It is not possible to produce banana drink samples from the banana syrup with a lesser sweetness level without reducing the thiamine content in the banana syrup. Thiamine fortification (2 mg of thiamine hydrochloride) is the simplest way to solve this problem. In fact, fortification of 10 mg-100 mg Thiamine has been recommended for

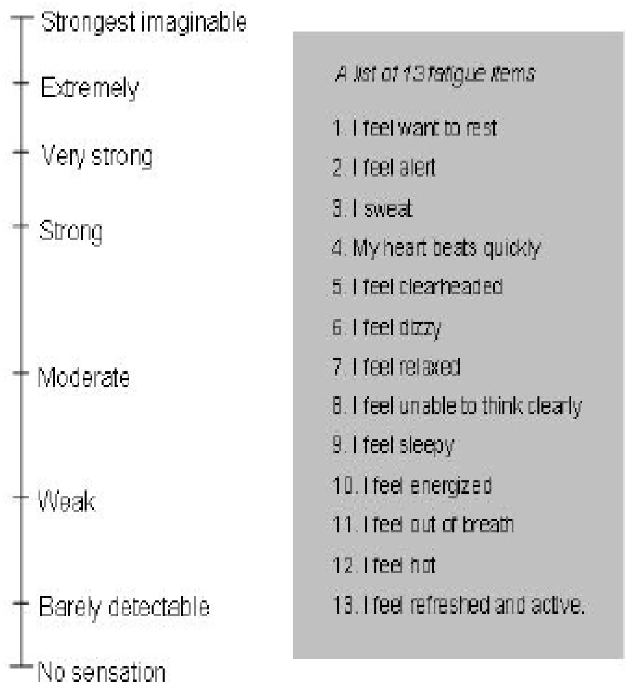

Figure 5. The Labeled Magnitude Fatigue Scale (LMFS) and a list of 13 fatigue items.

fatigue reduction by other relevant regulations, but the fortification is limited by the Thai RDI. It is also important in further development of energy drinks, to do more research on fatigue induction techniques, fatigue construction, and testing on different groups of participants with various ages etc.

The LMFS (Figure 5) was tested for its reliability and validity in the study of beverage samples, in six testing situations with internal consistency (by Cronbach's alpha) and test-retest reliability (by Pearson's correlation coefficients). From the results, Cronbach's alphas in all sample tests and in all sessions presented a high internal consistency of the LMFS. When the scale was tested with Thai subjects for test-retest reliability, a high degree of reliability was shown. It can be concluded that the fatigue score level measured by the LMFS is highly reliable with Thais.

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