PAPER

KRACHAI DAM (*KAEMPFERIA PARVIFLORA*) DRINKS: PHYSICOCHEMICAL PROPERTIES, CONSUMER ACCEPTANCE, PURCHASE INTENT, AND EMOTIONAL AND WELLNESS RESPONSES

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ABSTRACT

The rhizomes of Krachai Dam (*Kaempferia parviflora*) and their main effective methoxyflavones (5,7-dimethoxyflavone and 5,7,4'-trimethoxyflavone) have been reported to have beneficial medicinal effects. Additionally, emotions and wellness can play leading roles in product development in addition to liking. This study aims to formulate the Krachai Dam drink and to assess the effects of health benefit information on consumer acceptance, purchase intent, and emotional and wellness responses. The optimal formulation of Krachai Dam drink was 165 mg/100 ml dried Krachai Dam, 16% sugar and 0.32% citric acid, which had a high total phenolic content (TPC), total flavonoid content (TFC), and overall liking score. After consumers received the health benefit information of the product, increases were recorded in consumer acceptance, purchase intent, the highest price that consumers were willing to pay, and positive emotional and wellness responses.

Keywords: Krachai Dam drinks, *Kaempferia parviflora*, emotion, wellness, purchase intent

1. INTRODUCTION

Herbs have been recognized as having health benefits (FARZANEH and CARVALHO, 2015). Herbs and their extracts contain different bioactive compounds that can provide therapeutic effects. *Kaempferia parviflora* or Krachai Dam (KD) is a Thai herb that belongs to the Zingiberaceae family. Its rhizomes have been reputed for their beneficial medicinal effects. Pharmacological studies have claimed various benefits of KD and its main effective methoxyflavones, including cellular metabolism regulating activity, anticancer activity, vascular relaxation and cardioprotective activity, sexual enhancing activity, neuroprotective activity, antiallergic, anti-inflammatory, and antioxidative activity, antiosteoarthritis activity, antimicrobial activity, and transdermal permeation activity (CHEN *et al*., 2018). Normally, KD is used as a food supplement or traditional medicine in the form of capsules and tablets (CHEN *et al*., 2018; KANG *et al.,* 2016; MEKJARUSKUL and SRIPANIDKULCHAI, 2019). However, using KD in food products is limited, such as wine (VICHITPHAN *et al.,* 2007), yogurt (KANG *et al.,* 2016), and fermented juice (CHAIYASUT *et al.,* 2018). In Thailand, the use of KD in food supplements is approved by the Thai FDA (Thai Food and Drug Administration), which recommends using KD water extracts of no more than 200 mg of KD per day (Thai FDA, 2017). At higher doses, food products consisting of KD need more research and development to support preventive health care, improve new product options for consumers, and add value to agricultural products.

Classical sensory evaluations, such as consumer preference tests, seem to be insufficiently accurate at predicting whether a newly developed product will be successful in the market. Food-elicited emotions are introduced as a useful tool for new product development. Because emotions influence the eating behavior of people, including food choice, motivation to eat, and amount of food intake (JIANG *et al*., 2014), Jiang and others (2014) proposed that it is necessary for food industries to understand the emotional denotation of their products and use this connotation in the packaging, branding, and commercials for the marketing of their products. In recent years, several methods for measuring emotions associated with foods have been developed and reported, such as the EsSense Profile® (KING *et al*., 2010), consumer defined check-all-that-apply (CD-CATA) (NG *et al*., 2013), EmoSemio (SPINELLI *et al*., 2014) and the EmoSensory® Wheel (SCHOUTETEN *et al*., 2015). In addition, the health and wellness of food products is an interesting issue for consumers. Thus, King and others (2015) developed the WellSense Profile™, which is a questionnaire for measuring wellness associated with foods from a consumer perspective (KING *et al*., 2015). Accordingly, the emotional and wellness responses of consumers should be considered in food product development.

There are many kinds of herbal drinks in Thailand. Some herbal drinks are very popular, but some are not, even though they have health-promoting abilities. One reason is that there are many factors that influence buying decisions. An important factor is the emotional and wellness responses of consumers. This research aimed to formulate the Krachai Dam drink and to assess the effects of health benefit information on consumer acceptance, purchase intent, and emotional and wellness responses.

2. MATERIALS AND METHODS

2.1. Materials

Dried Krachai Dam rhizomes were purchased from Naikrajok Farm, Khao Kho, Phetchabun Province, Thailand. The Krachai Dam used in this research was cultivated in March 2018 and harvested in January 2019. Sugar was Mitr Phol brand from United Farmers & Industry Co., Ltd., Thailand. Citric acid (food grade) was purchased from Union Science Co., Ltd., Thailand.

2.2. Formulation and optimization of Krachai Dam drinks

Optimization of the herbal drink formulation was conducted using a central composite design (CCD), and the data were analyzed by using response surface methodologies (RSMs).

The three factors, including dried Krachai Dam (100-200 mg/100 ml), sugar (10-16%), and citric acid (0.2-0.4%), varied in 3 levels as low, middle, and high, which were coded as -1, 0, and 1, respectively (Table 1). A central composite design (face-centered design; alpha=1) consisted of a total of 18 runs (Table 2). Four replicates (runs 15, 16, 17, 18) at the center of the design were used to allow for estimation of the pure error as the sum of the squares.

The samples of 18 runs were prepared by using the process as follows. Dried Krachai Dam (KD) was extracted in water at 90°C for 10 min and filtered through two layers of white cloth. Sugar and citric acid were added to the KD extract, and the solution was adjusted to a specified volume by adding water and then pasteurized at 85°C for 10 min. A sample of the boiled KD drink was poured into a glass bottle while hot, closed with a bottle cap, and immediately cooled in cold water. The samples were stored at 4°C and subjected to analysis within 48 hours.

2.3. Determination of the physicochemical qualities of Krachai Dam drinks

To obtain the physicochemical properties, three replicate analyses were carried out for each sample.

The color of the Krachai Dam drink was measured at room temperature using a colorimeter (MiniScan EZ, Hunter Association Laboratory Inc., USA). CIE L*, a* and b* were determined and reported (LA PEÑA *et al*., 2010).

The pH of the Krachai Dam drink was determined using a pH meter (FiveEasy Plus, Mettler Toledo, Switzerland) (AYALA-ZAVALA *et al*., 2004).

The total acidity of Krachai Dam drinks was determined as the titratable acidity (AYALA-ZAVALA *et al*., 2004). Total acidity was determined by diluting each 5 ml aliquot of Krachai Dam drink with 95 ml of distilled water and then titrating to pH 8.2 using 0.1 mol/L NaOH.

The total soluble solids content of Krachai Dam drinks was determined at 20°C using a digital refractometer (0-85°brix, HI96801, Hanna Instrumants Inc., USA) (AYALA-ZAVALA *et al*., 2004).

The viscosity of approximately 500 ml of each herbal drink was measured using a rotary viscometer (Brookfield Ametek DV1, USA) at 60 rpm and 5°C (adapted from LA PEÑA *et al*., 2010).

Table 1. Factors and their levels for central composite design (face-centered design; alpha=1).

Level	Code level			True level		
	Krachai Dam	**Sugar**	**Citric acid**	**Krachai Dam** (mg/100 mL)	**Sugar** (%)	**Citric acid** (%)
Low	-1	-1	-1	100	10	0.2
Middle	0	0	0	150	13	0.3
High	1	1	1	200	16	0.4

Table 2. Central composite design arrangement (face-centered design; alpha=1).

Run	Code level			True level		
	Krachai Dam	**Sugar**	**Citric acid**	**Krachai Dam** (mg/100 mL)	**Sugar** (%)	**Citric acid** (%)
1	-1	-1	-1	100.00	10.00	0.20
2	-1	-1	1	100.00	10.00	0.40
3	-1	1	-1	100.00	16.00	0.20
4	-1	1	1	100.00	16.00	0.40
5	1	-1	-1	200.00	10.00	0.20
6	1	-1	1	200.00	10.00	0.40
7	1	1	-1	200.00	16.00	0.20
8	1	1	1	200.00	16.00	0.40
9	-1	0	0	100.00	13.00	0.30
10	1	0	0	200.00	13.00	0.30
11	0	-1	0	150.00	10.00	0.30
12	0	1	0	150.00	16.00	0.30
13	0	0	-1	150.00	13.00	0.20
14	0	0	1	150.00	13.00	0.40
15	0	0	0	150.00	13.00	0.30
16	0	0	0	150.00	13.00	0.30
17	0	0	0	150.00	13.00	0.30
18	0	0	0	150.00	10.00	0.30

The total flavonoid content of the Krachai Dam drinks was determined by using a modified colorimetric method, according to KAMTEKAR *et al*. (2014) with some modifications. Quercetin was used as a standard, and a series of standard solutions were prepared in the range of 100-1000 μg/mL. Briefly, 1 mL of sample or quercetin standard solution was mixed with 4 mL of distilled water, subsequently mixed with 0.3 mL of 5% sodium nitrite solution, and was allowed to react for 5 min. Then, 0.3 mL of 10% aluminum chloride was added and further reacted for 6 min before the addition of 2 mL of 1 M sodium hydroxide. Distilled water was added to bring the final volume of the mixture to 10 mL, and the solution was mixed well. The absorbance of the mixture was immediately measured at a wavelength of 415 nm against a prepared blank using a UV-VIS spectrophotometer (Libra S70, Biochrom Libra, UK). The flavonoid content was determined by a quercetin standard curve and expressed as the mean milligrams of quercetin equivalents per mL of sample±SD in triplicate.

The total phenolic content of Krachai Dam drinks was determined using the Folin-Ciocalteu method, according to RAHMAN *et al*. (2018) with some modifications. Gallic acid was used as a standard, and a series of standard solutions were prepared in the range of 0-125 μg/mL. A 1 ml sample of each Krachai Dam drink was transferred to a test tube and then mixed thoroughly with 2 ml of Folin-Ciocalteu reagent (10-fold diluted with distilled water). After mixing for 3 min, 10% (w/v) sodium carbonate (8 ml) was added. The mixture was mixed by using a vortex mixer and then allowed to stand for 30 min in the dark at room temperature. The absorbance of the mixture was measured at 760 nm using a UV-VIS spectrophotometer. The blank consisted of a solution with only Folin-Ciocalteu reagent (without sample). Determinations were carried out in triplicate and calculated from a calibration curve obtained from gallic acid. The total phenolic content was expressed as milligrams of gallic acid equivalents (mg GAE/mL sample). Data are expressed as the mean values±standard deviation (SD).
The antioxidant activity of Krachai Dam drinks was determined using the scavenging activity of the stable radical DPPH (1,1-diphenyl-2-picrylhydrazyl) according to the method of IQBAL *et al*. (2015) with some modifications. Ascorbic acid was used as a standard, and a series of standard solutions were prepared in the range of 1-8 μg/ml. A series of sample concentrations with different ratios of samples to ethanol, i.e., 10:10, 8:10, 6:10, 4:10, 2:10, and 1:10 were prepared. Then, a solution of standard or sample (2 mL) was mixed with 2 ml of 0.1 mM DPPH-ethanol solution at room temperature. After incubation for 30 min in the dark, the absorbance of the mixture at 517 nm was determined using a UV-VIS spectrophotometer. The control was prepared without sample, while the blank contained DPPH solution. The percent DPPH radical scavenging activity of the standard solution and each sample were calculated as:

$$\text{DPPH radical scavenging activity (\%)} = [(A_{control} - A_{sample})/A_{control}] \times 100$$

The percent DPPH radical scavenging activity was plotted against the sample concentration to determine the amount of sample necessary to inhibit the DPPH radical concentration by 50% (IC_{50}). The assay was carried out in triplicate, and the data are expressed as the mean values±standard deviation (SD).

2.4. Assessment of the overall liking of Krachai Dam drinks

Sensory evaluation for the overall liking of 18 samples of Krachai Dam drinks was performed by 128 consumer panelists (51.6% male, 48.4% female, mean age=40.3). Panelists between the ages of 18 and 65 years were screened for potential food allergies, and they consumed herbal drinks at least once a week. Each sample of Krachai Dam drink (30 mL; Table 2) was put in a clear plastic cup, labeled with a three-digit code, and presented to all panelists in a random order. The samples were divided into three sets (6 samples per set) with a 10 min break between each set to prevent sensory fatigue. Panelists were asked to rate their overall liking of each sample using a 9-point hedonic scale (9=like extremely, 5=neither like nor dislike, 1=dislike extremely), and they were given drinking water to wash their palates before testing the next sample.

2.5. Consumer acceptance testing of the formulated Krachai Dam drink

The optimal formulation of Krachai Dam drink from the CCD was assessed for consumer acceptance by using a questionnaire that contained 3 sections, as shown in Table 3. A 30 mL sample of the optimally formulated Krachai Dam drink was put in a clear plastic cup and labeled with a three-digit code before being presented to all consumers (n=406; Table 8).

Table 3. Details of the questionnaire for assessing consumer acceptance of the optimally formulated Krachai Dam drink.

Section	Topic	Assessment
1	Before consumers received the details of the product and the benefits of Krachai Dam drinks.	- Emotional and wellness responses - Consumer acceptance - Purchase intention
2	After consumers received the product details and health benefit information of Krachai Dam drinks as following: "The product that you are testing is Krachai Dam drink, which was produced from natural raw materials, no preservatives, no coloring agents, and no flavoring agents." Krachai Dam (*Kaempferia parviflora*) or black ginger is a Thai herb which belongs to the Zingiberaceae family. Its rhizomes have been researched for beneficial health effects, such as cellular metabolism regulating activity, anticancer activity, vascular relaxation and cardioprotective activity, sexual enhancing activity, neuroprotective activity, antiallergic, anti-inflammatory, and antioxidative activity, antiosteoarthritis activity, antimicrobial activity, and transdermal permeation activity (CHEN *et al.*, 2018).	- Emotional and wellness responses - Consumer acceptance - Purchase intention
3	Demographic information of the participants.	- Gender - Age - Educational level - Occupation - Monthly income

Emotional and wellness responses were assessed by using the rate-all-that-apply (RATA) approach (adapted from JAEGER *et al.*, 2018). Emotional terms from the EsSense profile® (KING *et al.*, 2010) and wellness terms from the WellSense Profile™ (KING *et al.*, 2015) were screened for relevance to the Krachai Dam drink using check-all-that-apply (CATA) (n=239; 46% male and 54% female). Emotional and wellness terms that were selected for at least 18% of participants were considered to have relevance to Krachai Dam drinks. The results of the term screening showed that 12 terms were selected, including seven positive emotion terms (active, energetic, good, happy, polite, satisfied, and warm) and five wellness terms (comforted, healthy, invigorated, relaxed, and refreshed). Additionally, three negative emotion terms (bored, disgusted, and worried) were added to the questionnaire to include both positive and negative emotions. Traditionally, at least 20% frequency of use was recommended for term screening by using the CATA questionnaire (KING *et al.*, 2010). However, some research has used lower than 20% frequency for screening relevant terms to products (SCHOUTETEN *et al.*, 2015). In addition, if the study objective was to assess the negative side of food experience, screening criteria in terms of usage frequency of negative emotions may be lower than that of positive emotions (JIANG *et al.*, 2014). Thus, a total of 15 emotional and wellness terms were listed randomly in the questionnaire. Consumers were asked to select the emotional and wellness terms that described how they felt after consuming the product and then rate the intensity of the

selected terms on a 5-point intensity scale from 1=slightly to 5=extremely (RATA approach).
Consumer acceptance was assessed by using a yes/no scale. Purchase intention was evaluated using a 3-point scale (1=purchase, 2=not sure, and 3=no purchase).

2.6. Statistical analysis

The physicochemical properties and overall liking data were analyzed by using ANOVA followed by DMRT to determine significant differences between treatments. Statistical analyses were performed by using IBM SPSS Statistics 19. The results were considered significant at a level of $p<0.05$ (95% confidence interval).
Response surface methodologies were conducted to determine the regression coefficients and statistical models for the experimental data, aiming at an overall optimal region for the response variables. After removing the nonsignificant coefficients from the initial model, three-dimensional surface plots were used to explain the effects of the independent variables (ingredients) on the response variables (product qualities). Graphical and numerical optimum formulations and predicted values for the response variables were based on the response optimizer.
For the consumer acceptance test, differences in the emotional and wellness responses before and after consumers had received the details and benefits of the Krachai Dam products were analyzed using a t-test. Consumer acceptance and purchase intent were analyzed using a frequency count, and the differences before and after the consumers had received the details and benefits regarding the Krachai Dam products were analyzed using the McNemar and McNemar-Bowker tests, respectively. Statistical analyses were performed using IBM SPSS Statistics 19. The results were considered significant at a level of $p<0.05$ (95% confidence interval).

3. RESULTS AND DISCUSSION

3.1. Formulation and optimization of the Krachai Dam drink

The physicochemical properties and overall liking of the KD drink products were evaluated. Table 4 shows that all physicochemical properties were significantly different between the 18 treatments, including L*, a*, b*, pH, % acidity, total soluble solids, viscosity, total phenolic content (TPC, μg GAE/ml), total flavonoid content (TFC, μg QU/ml) and antioxidant activity as DPPH scavenging activity (IC_{50}, ml/ml). Additionally, the overall liking showed significant differences between the 18 treatments.
The relationship between the responses and variables of CCD from response surface methodology are shown in Table 5. It should be noted that the adjusted R-square value of the b* value is very low, so this predicted equation is not appropriate to predict the b* value. The adjusted R-square values of % acidity, TSS, viscosity, TPC, and TFC are higher than 0.9, which means that their predicted equations provide confidence in the prediction of the values of the responses.
Then, the optimized formulation was predicted. The results show that the optimized formulation consisted of 165 mg/100 ml dried KD, 16% sugar and 0.32% citric acid (Table 6), which had a high predicted value of total phenolic content (TPC=40.10 μg/ml), total flavonoid content (TFC= 77.85 μg/ml), and overall liking (OA=7.1).

Table 4. Physicochemical properties and overall liking of Krachai Dam drinks from the central composite design treatments.

Run*	L*	a*	b*	TSS (°brix)	Viscosity (cP)	pH	% Acidity	TPC (µg GAE/ml)	TFC (µg QU/ml)	IC_{50} (ml/ml)	OA
1	70.69^{a}±0.81	5.63^{e}±0.34	-4.13^{cde}±0.11	10.23^{gh}±0.38	3.10^{fgh}±0.10	2.64^{a}±0.05	0.19^{l}±0.00	24.61^{i}±0.54	34.32^{m}±1.35	1.48^{bc}±0.01	5.42^{fg}±1.46
2	70.39^{a}±1.19	6.25^{de}±0.22	-4.09^{bcde}±0.13	10.73^{g}±0.47	3.13^{efgh}±0.15	2.43^{fg}±0.04	0.43^{b}±0.01	24.06^{i}±0.61	36.63^{l}±1.97	1.43^{d}±0.01	5.23^{g}±1.41
3	69.94^{ab}±0.97	6.17^{de}±0.22	-4.07^{bcde}±0.06	15.30^{bc}±0.95	3.43^{ab}±0.12	2.61^{ab}±0.04	0.20^{k}±0.00	26.90^{h}±0.07	40.60^{k}±1.11	1.56^{a}±0.01	5.90^{e}±1.11
4	68.31^{cd}±0.11	5.75^{e}±0.23	-3.86^{abc}±0.13	14.83^{c}±0.06	3.40^{abc}±0.17	2.39^{h}±0.01	0.44^{a}±0.00	26.15^{h}±1.52	43.81^{j}±2.14	1.52^{ab}±0.05	5.37^{fg}±1.16
5	65.21^{f}±0.44	10.28^{a}±0.77	-4.50^{f}±0.16	9.93^{hi}±0.06	3.07^{gh}±0.15	2.61^{ab}±0.03	0.21^{j}±0.01	37.72^{d}±0.42	76.24^{e}±1.18	1.22^{i}±0.05	5.27^{fg}±1.23
6	64.62^{fg}±0.57	9.70^{ab}±0.69	-4.00^{abcd}±0.29	9.30^{i}±0.70	2.97^{h}±0.21	2.41^{gh}±0.01	0.44^{a}±0.00	43.30^{c}±0.24	99.45^{a}±2.94	1.36^{ef}±0.02	5.13^{g}±1.55
7	66.07^{ef}±0.64	10.49^{a}±0.87	-4.02^{a-e}±0.37	15.97^{ab}±0.06	3.47^{a}±0.12	2.60^{b}±0.02	0.23^{i}±0.00	44.14^{bc}±0.57	82.14^{d}±1.55	1.37^{e}±0.02	6.37^{d}±1.28
8	65.88^{ef}±0.35	10.47^{a}±1.06	-4.03^{a-e}±0.19	15.43^{bc}±0.06	3.33^{a-e}±0.06	2.47^{def}±0.02	0.42^{c}±0.00	47.67^{a}±0.53	91.12^{fb}± 1.02	1.34^{efg}±0.04	6.61^{bcd}±1.38
9	69.54^{abc}±0.65	5.63^{e}±0.28	-3.75^{ab}±0.14	13.93^{d}±0.40	3.30^{a-f}±0.10	2.50^{cd}±0.01	0.31^{g}±0.00	26.86^{h}±0.26	45.09^{j}±0.59	1.50^{b}±0.04	5.64^{ef}±1.60
10	63.49^{g}±0.38	9.15^{bc}±0.67	-3.98^{abcd}±0.17	13.90^{d}±0.10	3.33^{a-e}±0.06	2.48^{de}±0.04	0.36^{d}±0.01	44.91^{b}± 0.53	87.40^{c}±1.94	1.22^{i}±0.01	6.43^{d}±1.71
11	69.48^{abc}±0.30	8.25^{c}±0.74	-4.08^{bcde}±0.17	10.40^{gh}±0.44	3.07^{gh}±0.15	2.54^{cd}±0.01	0.32^{f}±0.00	33.74^{g}±0.10	68.04^{f}±1.02	1.44^{cd}±0.01	6.57^{cd}±1.51
12	68.69^{bc}±0.59	8.82^{bc}±0.38	-4.32^{def}±0.06	16.20^{a}±0.10	3.37^{abcd}±0.06	2.43^{efg}±0.01	0.35^{e}±0.01	34.20^{fg}±0.19	66.24^{fg}±0.44	1.30^{gh}±0.01	7.03^{a}±1.39
13	63.60^{g}±0.66	7.02^{d}±0.34	-3.69^{a}±0.07	13.87^{d}±0.12	3.20^{c-g}±0.10	2.54^{c}±0.02	0.24^{h}±0.00	34.36^{fg}±0.45	54.71^{i}±0.22	1.31^{fg}±0.02	6.94^{abc}±1.46
14	67.25^{de}±0.42	9.65^{ab}±0.69	-4.37±0.07	13.03^{e}±0.31	3.17^{d-h}±0.06	2.43^{fgh}±0.01	0.42^{c}±0.00	37.64^{d}±0.37	56.12^{i}±0.38	1.22^{i}±0.02	6.91^{abc}±1.33
15	66.09^{ef}±2.42	8.64^{bc}±0.48	-4.50±0.45	12.30^{f}±0.20	3.20^{c-g}±0.10	2.45^{efg}±0.02	0.32^{f}±0.00	35.14^{f}±0.14	64.71^{g}±0.22	1.31^{fg}±0.02	7.25^{a}±1.53
16	64.70^{fg}±0.39	8.35^{c}±0.54	-4.13^{cde}±0.06	13.87^{d}±0.64	3.27^{a-g}±0.06	2.48^{de}±0.01	0.32^{f}±0.00	37.55^{d}±0.71	59.83^{h}±0.22	1.26^{hi}±0.04	7.10^{a}±1.73
17	64.82^{fg}±0.44	8.36^{c}±0.56	-4.29^{def}±0.03	13.07^{e}±0.15	3.23^{b-g}±0.15	2.45^{efg}±0.01	0.32^{f}±0.00	36.24^{e}±0.40	63.94^{g}±0.22	1.24^{i}±0.01	6.97^{ab}±1.97
18	64.73^{fg}±0.37	8.35^{c}±0.59	-4.25^{def}±0.17	13.00^{e}±0.26	3.23^{b-g}±0.06	2.46^{def}±0.01	0.32^{f}±0.00	37.01^{de}±0.43	65.60^{g}±0.80	1.25^{hi}±0.01	6.86^{abc}±1.93

*Corresponding to formulation runs listed in Table 2.
Values are means±standard deviations (SD).
Values in the same column with different letters are significantly different ($p<0.05$).
Abbreviations: TSS, total soluble solid; TPC, total phenolic content; TFC, total flavonoid content; IC_{50}, antioxidant activity as DPPH scavenging activity; OA, overall acceptability.

Table 5. The relationship between the responses and variables of central composite design.

Response	Predicted equation*	Adjusted R^2
L*	$Y=65.698-2.360K+0.205K^2-0.150S+2.775S^2+0.094C-0.885C^2$	0.70
a*	$Y=8.295+2.066K-0.775K^2+1.159S-0.370S^2+0.223C+0.170C^2$	0.84
pH	$Y=2.46+0.03K^2-0.009S+0.005S^2-0.087C+0.025C^2$	0.87
%acidity	$Y=0.328-0.009K-0.0002K^2+0.005S-0.0002S^2+0.108C-0.054C^2$	0.96
TSS (°brix)	$Y=13.409-0.049K+0.158K^2+2.714S-0.457S^2-0.198C-0.307C^2$	0.92
Viscosity (cP)	$Y=3.236-0.019K+0.075K^2+0.166S-0.190S^2-0.027C-0.054C^2-0.030KC$	0.96
TPC (μg/ml)	$Y=36.213-8.917K-0.057K^2+1.563S-1.967S^2+1.110C+0.061C^2+1.303KC$	0.97
TFC (μg/ml)	$Y=63.275-23.590K+3.213K2+0.923S+4.110S^2 + 3.910C-7.621C^2+3.333KC$	0.97
IC_{50}(ml/ml)	$Y=1.278-0.099K+0.075K^2+0.015S-0.081S^2-0.007C-0.020C^2$	0.65
Overall liking	$Y=7.046+0.224K-1.012K^2+0.367S-0.247S^2-0.064C-0.122C^2+0.244KS$	0.94

*Y=Response, K=Dried KD, S=Sugar, C=Citric acid.
Abbreviations: TSS, total soluble solid; TPC, total phenolic content; TFC, total flavonoid content; IC_{50}, antioxidant activity as DPPH scavenging activity.

In both adults and children, the WHO recommends reducing the intake of free sugars to less than 10% of total energy intake (WHO, 2015), which is equivalent to 50 g for a person of healthy body weight consuming approximately 2000 calories per day. In this research, the sugar level of the optimal formulation that consists of 16 g of sugar per serving (100 mL) is quite high but less than the sugar intake recommendation of the WHO. Moreover, 12 brands of Krachai Dam drinks from a market survey in Thailand consist of 8-20% sugar (data not shown). Additionally, the percent sugar in the optimal formulation is in the range of traditional Krachai Dam drinks. However, we recommend that future studies reduce the sugar or substitute the sugar using no calorie materials such as stevia.

Table 6. The optimal formulation of the Krachai Dam drink.

Ingredient	Code level	True level
Dried Krachai Dam	0.4	165 mg/100 ml
Sugar	1	16%
Citric acid	0.3	0.32%

Next, the formulated KD drink products were produced, and the physicochemical properties and overall liking were evaluated. The data were analyzed by using a t-test to compare the differences between the predicted values from the RSM and the actual value of the formulated product.
The results (Table 7) show that none of the physicochemical properties, except % acidity, were significantly different between the formulated KD drinks and their predicted values.

3.2. Consumer acceptance of the formulated Krachai Dam drink

A consumer acceptance test of KD drinks was administered to 406 consumers whose demographic information is shown in Table 8 using a Central Location Test in Khon Kaen province. Fifty-four percent of the participants were female and 45% were male, and the participants were mostly over the age of 22 years. Their education was mostly at the Bachelor's degree level. Most were self-employed. Their monthly income was generally in the range of 10,000-20,000 baht.

Differences in emotional and wellness responses before and after the consumers received the details of the Krachai Dam product and the health benefit information were analyzed using a t-test, and the results are shown in Figure 1. After receiving the product details, all positive emotional and wellness responses were clearly higher than before the consumers had received product details ($p<0.05$). The participants did not have the "bored" emotion, while "disgusted" and "worried" responses had mean scores of nearly zero and no differences before and after receiving the product details (data not shown). Generally, most emotions elicited from foods are positive emotions, even when evaluating not well-liked products, and the intensity of negative emotions is relatively low (SPINELLI and JAEGER, 2019).

Consumer acceptance and purchase intent were analyzed using % frequency, and the differences before and after the consumers received the details of the product and its benefits were analyzed using the McNemar test and the McNemar-Bowker test, respectively. The highest price that consumers were willing to pay was reported as the mean value±standard deviation (SD). The differences between the highest price before and after consumers received the product details and health benefit information were compared using a t-test. The results (Table 9) show that most participants accepted the product (97.77% before and 100.00% after), and consumer acceptance before and after receiving the product details was not significantly different ($P>0.05$).

After consumers received the product details and health benefit information, the purchase intention (88.92% before and 96.31% after) and the highest price that consumers were willing to pay (17.58 baht/100 mL before and 29.02 baht/100 mL after) were significantly higher ($p<0.05$).

Table 7. Physicochemical properties and overall liking of formulated KD drinks.

Physicochemical properties	**Predicted value**	**Actual value** (mean±SD)	**t-test** (p-value)
L*	67.59	66.59±0.67	0.122
a*	9.63	9.18±0.67	0.364
b*	-4.25	-4.35±0.10	0.216
pH	2.45	2.43±0.01	0.130
% acidity	0.36	0.35±0.0015	0.006
TSS (°brix)	15.68	15.53±0.06	0.251
Viscosity (cP)	3.37	3.37±0.15	0.973
TPC (μg GAE/ml)	40.10	38.13±0.85	0.057
TFC (μg QU/ml)	77.85	76.12±1.02	0.098
IC_{50}(ml/ml)	1.34	1.32±0.04	0.516
Overall liking	7.17	7.07±1.19	0.499

Abbreviations: TSS, total soluble solid; TPC, total phenolic content; TFC, total flavonoid content; IC_{50}, antioxidant activity as DPPH scavenging activity.

Table 8. Demographic information of participants (n=406) in consumer tests of formulated KD drinks.

Demographic information	Frequency count	Percent
1. Gender		
Female	220	54.2
Male	186	45.8
2. Age		
18-21 years	23	5.7
22-40 years	134	33.0
41-59 years	128	31.5
≥60 years	121	29.8
3. Education level		
Secondary school	129	31.8
Bachelor's degree	227	55.9
Postgraduate	50	12.3
4. Occupation		
Student	30	7.4
Government employee	71	17.5
Self-employed/Merchant	118	29.0
Employee	60	14.8
Private company employee	33	8.1
Retiree	65	16.0
Unemployed	21	5.2
Other	8	2.0
5. Monthly income		
<10,000 baht	109	26.9
10,001-20,000 baht	137	33.7
20,001-30,000 baht	83	20.4
30,001-40,000 baht	50	12.3
40,001-50,000 baht	15	3.7
>50,000 baht	12	3.0

In summary, the product details and health benefit information of the KD drink increased the emotion and wellness responses, consumer acceptance, purchase intention, and the highest price that consumers were willing to pay. This result may be influenced by the relationship between emotions and food choice. Emotions can provide an internal stimulus or state that elicits a useful, corrective food choice. On the other hand, food may influence emotions through various factors, such as sensory and hedonic effects, social context, cognitive expectations, psychological distraction, appetite alteration, and brain function (GIBSON, 2006). Food companies must understand the emotional meaning of their food products and use these messages in the forms of packaging, branding, and advertisements to market their products. This also helps with finding target consumers, modifying emotional needs towards different consumers and discovering new markets (JIANG *et al.*, 2014). Therefore, the sensory-emotional optimization of products has been suggested as an alternative to sensory-hedonic product optimization based on the relation of a sensory property and an emotion (SPINELLI and JAEGER, 2019). In addition, a combination of sensory intensities and emotional responses have been used to predict the consumer acceptance of commercial products such as vegetable juice (SAMANT and SEO, 2019).

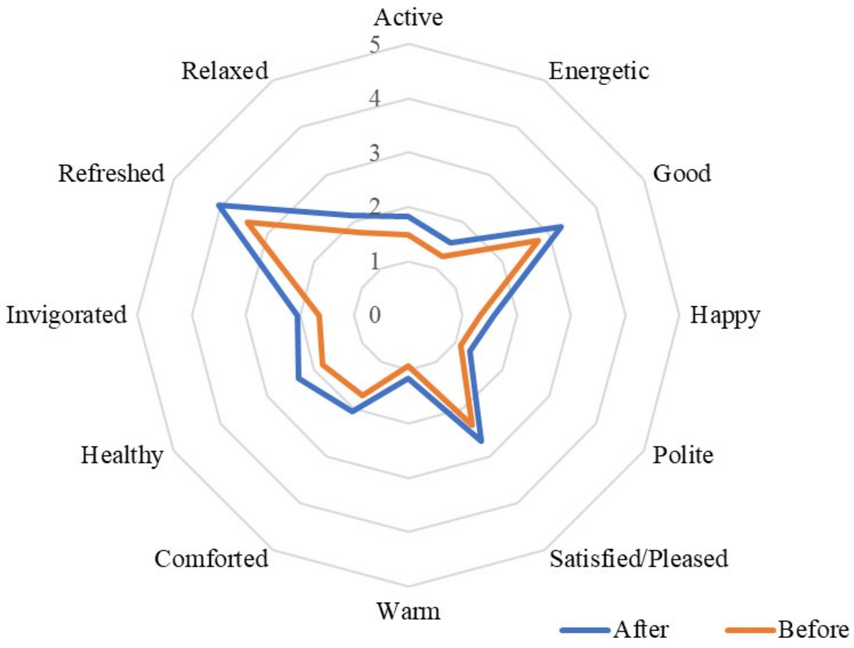

Figure 1. Positive emotional and wellness responses of the optimal formulated Krachai Dam drink before and after the consumers received the product details and benefits of KD (t-test, p<0.05).

Table 9. Consumer acceptance, purchase intention, and the highest price that consumers were willing to pay for the Krachai Dam drink before and after they received the product details and health benefit information (n=406).

Consumer test	Before	After	Statistical analysis
Consumer acceptance			
Accept	97.77%	100.00%	McNemar test,
Not accept	1.23%	0.00%	P-value=0.063
Purchase intention			
Purchase	88.92%	96.31%	McNemar-
Not sure	10.34%	3.45%	Bowker test,
No purchase	0.74%	0.24%	P-value=0.000
Highest price for 100 mL/bottle (baht)*	17.58±11.12	29.02±15.17	t-test, P-value=0.000

Values are means±standard deviations (SD).

4. CONCLUSIONS

The optimal formulation of the KD drink was 165 mg/100 ml dried KD, 16% sugar and 0.32% citric acid, which had high total phenolic content (TPC=38.13 μg/ml), total flavonoid content (TFC= 76.12 μg/ml), and overall liking (OA=7.07). Most of the consumer panels (97.77%) were satisfied with the formulated product. After the consumers received the product benefit information, consumer acceptance, purchase intent, the highest price that consumers were willing to pay, and their positive emotional and wellness responses increased.

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