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Food Science

AN INSPECTION METHOD FOR FOOD INDUSTRY USING GOLDEN SECTION SEARCH

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Abstract

Product size and dimension are essential keys in the food industry to control the quality of the product. The conventional methods, size measuring method based on average values (SMA) and size measuring method based on bounding box (SMB), are mostly used methods to identify the size and dimension of products. Both methods use the concept of the thresholding method to separate the object from the background. However, both methods use the fixed thresholding values and the average value to determine the number of pixels that cause the error of the product size. This paper contributes the method to determine the optimal thresholding value and uses the median of the region of interest grid to determine the size of the product, called the golden section search method. The experiments which were based on rectangular shape products show three important results. First, the contributed method uses a smaller number of images to determine the optimal thresholding value. Second, the contributed method gives a small error comparison between computation size and the actual size. Finally, the comparison results show that by using the same number of images and thresholding values, the contributed method overcomes the conventional methods in terms of the error in the size of the food product.

Keywords: Machine Vision, Golden Ratio, Inspection, Industry 4.0

Introduction

Industry 4.0, the fourth industrial revolution, and the digital change that it entails are quickly progressing. The digital revolution is transforming people's lives and careers, and the public remains hopeful about the potential Industry 4.0 may provide for long-term sustainability (Ghobakhloo,2020). To be suited for Industry 4.0, the quality inspection must become "fast", "accurate", "reliable", flexible" and "holistic" (Imkamp et al., 2016) Furthermore, machine conditions, manufacturing processes, and manufacturing decision-making all have an impact on product productivity, performance, and quality. Additionally, the major goal of combining manufacturing with information technology is to increase production flexibility. As demand changes and batch sizes shrink, this flexibility is required to economically counteract the desire for personalized items. Product quality needs are closely tied to reduced tolerances of quality characteristics and parameters, and hence to increased precision in manufacturing and the accompanying measuring technologies. This progression can be seen in the steady rise in the precision of machine tools and measuring technologies over the last 150 years since the commencement of the industrial revolution. To achieve zero faults in production, a symbiosis of information and communications technology (ICT), artificial intelligence (AI) models, quality inspection tools, and data usage is required to adapt to changing surroundings (May & Kiritsis, 2019). Cloud computing, industrial big data, industrial networking, industrial robots, three-dimensional prototyping, knowledge-based automation, industrial communication security, virtual reality, and artificial intelligence are all technical parts of the industry 4.0 standard.

In the food industry, the industry 4.0 standard is being used to establish a mass customization approach. That might be approach mass customization more difficult and different than a textile or automobile assembly plant, however, the food industry can benefit from significant cost savings. A different take on the food industry's mass customization. The design, manufacture, operation, and maintenance of products and production systems will all be altered by the new industry platform. Routray and Mishra (2011) showed that production systems based on the concept of industry 4.0 increase speed by 30% and 25% more efficiently because of interconnectivity and interaction between parts, machines, and operators, allowing for more mass customization. Xiaorong et al., (2015) provide a revolutionary IoT architecture for tracking and tracing agriculture from the field to the supply chain and food processing facilities. They propose to develop a food logistics safety tracking system using IoT technologies, assess the system's functioning principles and components, and acquire positioning, production, and safety information about the target food goods by a series of calculations. However, the product quality must inspect the outcomes of all procedures.

Quality control is an essential component of any manufacturing process. To meet this growth target, producers must increase their production rate while adhering to certain quality control limits. The development of a higher-quality management system is the most significant technological advancement for business productivity. Intelligent visual inspection systems and artificial intelligence on production lines are becoming increasingly important in meeting the growing demand for high-quality products. Due to the ever-increasing quality requirements of manufacturers and customers. One of the fastest-growing and most extensively utilized technologies in the field of production and quality control is machine vision. Every manufacturing industry aims to produce the greatest possible final product. The most essential criteria in product quality are shape and size. The parameters must be devoid of defects in high-quality products.

Machine vision-based (MVB) technologies have emerged as a viable alternative for checking various products. These approaches are used in a variety of applications, including fabric defect detection (Ngan et al., 2011), fault diagnosis of machine tools (Liu et al., 2022), automated assembly (Chauhan & Surgenor, 2017), and food inspection and grading (Hemamalini et al., 2022). In the MVB inspection system, preprocessing is a filter, edge detection or image segmentation, feature extraction (including statistical and shape-related features), and classification. Benefits of an automatic inspection system include assuring a high level of production, high-speed inspection, and the removal of human operators. The visual inspection system may be approached in three ways (Derganc et al., 2003). The first approach works by matching templates. An image is compared to one or more reference images using this approach. A rule-based method for detecting rules that have been broken. Machine vision and learning are used in the final technique. However, Derganc et al., (2003) way to inspection technique is incompatible with industry 4.0 concepts (e.g., fast, accurate reliable, flexible, and holistic).

The remainder of the paper is laid out as follows: in section 2, relevant efforts based on product quality to assist Industry 4.0 are briefly examined. The basic algorithm is highlighted in Section 3. To check the findings shown in Section 4 as fast, accurate, reliable, and flexible. Section 5 and 6 summarize the key findings of this study and offers a research topic for the future.

Research Objective

This paper proposes a simple inspection strategy that focuses on the rapid change in technology, industries, and societal patterns and processes in the twenty-first century as a result of increased interconnectivity and smart automation. Three points are given in the article. In the current state of the food industry, the first is straightforward to implement. The second factor is the algorithm's resiliency to image noise. The algorithm's output was shown to be fast, accurate, reliable, and flexible in the last point.

Literature Review

The product was manually inspected in the traditional methodology, which had disadvantages. Because small-scale enterprises could not afford the gear and equipment needed for product creation and detection, they relied on manual labor to complete the task. Manual labor, without a doubt, resulted in a time-consuming and inaccurate process (Vithu & Moses, 2016). Witsarut et al. (2018) use machine vision to examine the pill during the manufacturing process. To check the failure in the manufacturing line, they utilize the grayscale approach with the bounding box method, which is a box for a closing area. Machine vision systems can replace human (visual) inspection methods and have thus acquired wide adoption in industries as a tool for the quality evaluation of agricultural products.
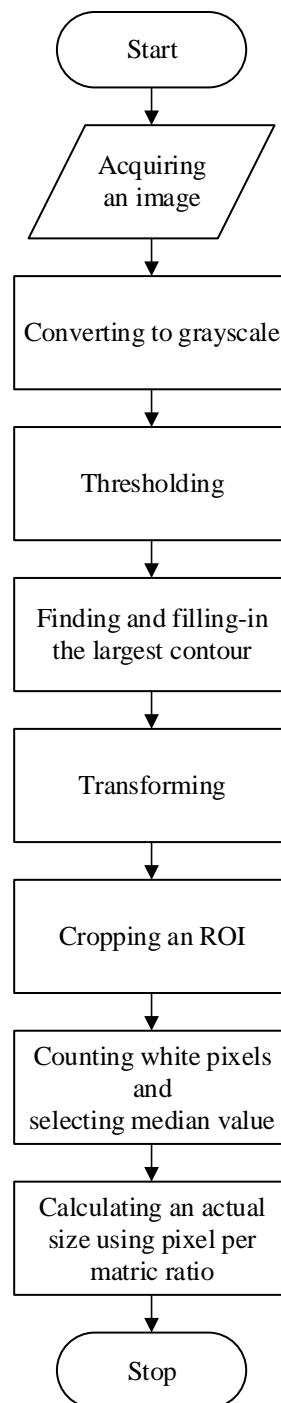
The food industry's quality assessment is difficult and influenced by environmental factors. Non-destructive quality assessment methods such as machine vision (Mahajan et al.,2015), near-infrared spectroscopy (Guindo et al., 2016), nuclear magnetic resonance spectroscopy (Horigane et al., 2013), electronic nose (Lu et al., 2015), Fourier transform infrared spectroscopy (Ferreira et al., 2015), x-ray techniques (Guelpa et al., 2015) and hyperspectral imaging (Ravikanth et al., 2015) are known to overcome such human limitations. Other approaches, such as machine learning, have been applied (e.g., Support vector machine (Chen et al., 2019), k-nearest neighbor (Banić et al., 2019), Feature Extraction, and Artificial neural network (Kunghun et al., 2020), Convolutional neural network (Wang et al., 2020)).

Saif et al., (2022) recommend using the MVB with IoT. Because the IoT has several applications in various industries, using this new technology in computer vision would help the system due to its many possibilities. A computer vision system, for example, may contain smart IoT cameras that gaze at the manufacturing line and collect photos, which are then algorithmically matched to a predetermined image to detect faulty goods. Benbarrad et al., (2021) suggest merging MVB with machine learning to separate the system to edge real-time processing and cloud computing. The objective is to make the machine or computer capable of offering answers to difficult issues by processing a limitless quantity of information.
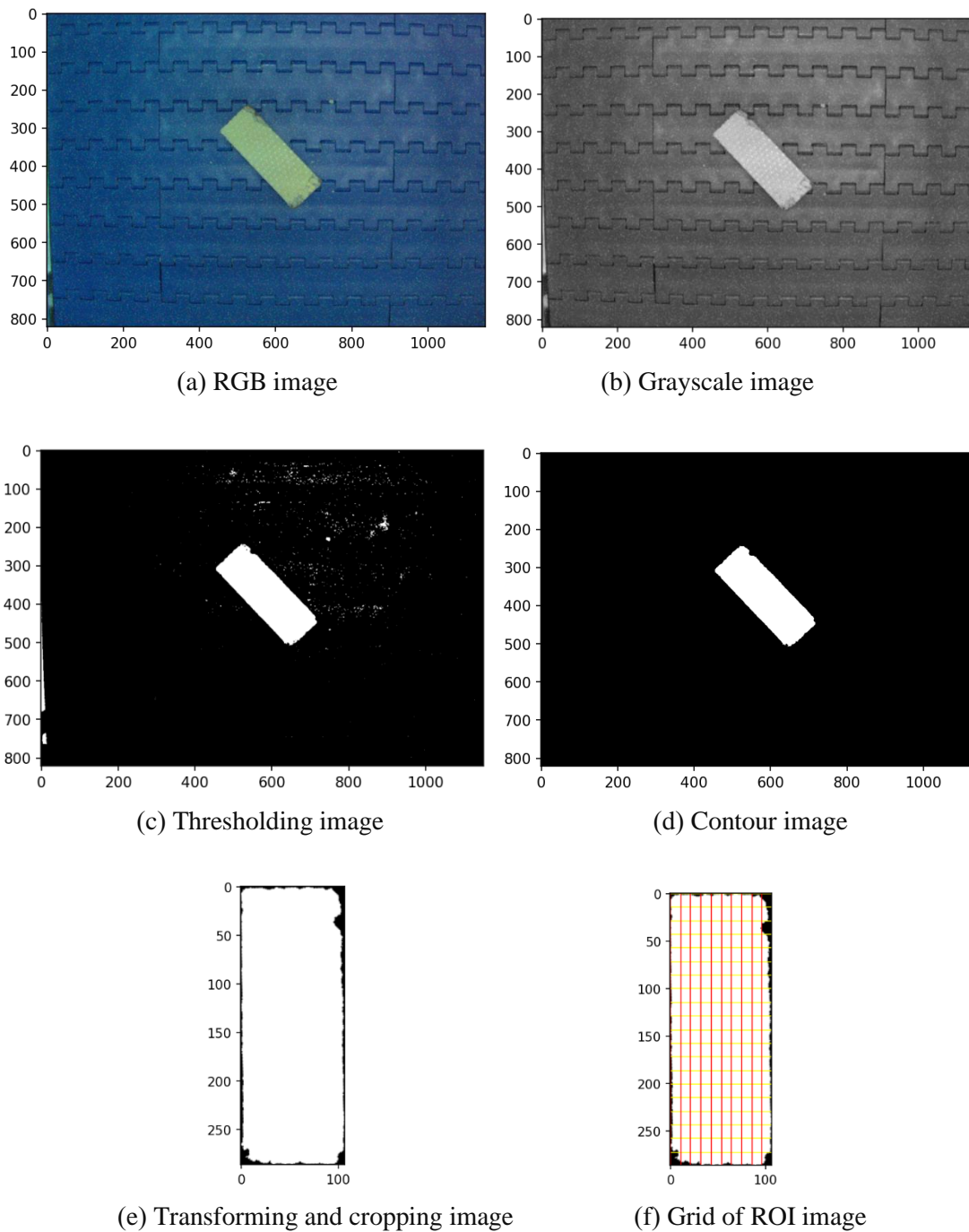
Methodology

This section explains the algorithm, namely, the size measuring method based on median values (SMM), in detail. The object must be inspected in seven steps as shown in Picture 1 (i.e., convert color, isolate the background, fit contour, transform, crop, select the value, and measurement). We use the ACA4600-10uc with the Basler C125-0818-5m f1.8 f8mm lens, which has a CMOS sensor with a resolution of 4608 x 3288 pixels. and a frame rate of 120 frames per second. Due to the limitation, we set a resolution of an image to be 1152 x 822 pixels to minimize the processing time.

If the colors of the object are clearly distinguishable, the thresholding technique can be used to differentiate it from the background. Traditionally, the threshold value is modified by a human using a trial-and-error method that takes time to select the proper thresholding value. However, we propose optimizing the thresholding value with the golden section search. Because the benefit of optimizing is to shorten the time it takes to locate the value and lower processing costs. After isolating the background by thresholding value, we use contour detection to find an object in the image by following the biggest contour. The filling in the shape to prevent the holds caused by the preceding technique. After that, the perspective transformation is used to transform the biggest contour image so that it can be measured vertically or horizontally. The region of interest (ROI) image will be extracted by cropping the transformed image. In the ROI image, the pixel counting process is to draw a line on the vertical and horizontal, 10 and 20, correspondingly. The grid of ROI image will count only the white pixels in each grid. The last step is calculating the real size by multiplying the median value of white pixels on each side by the pixel per matric ratio. Picture 2 shows an example of the image processing outcome.

Picture 1: Flowchart of the SMM algorithm

(a) RGB image

(b) Grayscale image

(c) Thresholding image

(d) Contour image

(e) Transforming and cropping image

(f) Grid of ROI image

Picture 2: Example of the image processed by the proposed method

Results

In this study, two key experiments were conducted to evaluate the performance of the proposed method. The first experiment uses a variable number of input images to test the golden section search for optimizing the thresholding value in terms of time and accuracy. The second experiment is to evaluate the size measuring method based on median value (SMM) by comparing with the conventional size measuring method based on bounding box (SMB) and the size measuring method based on average value (SMA). Two types of input images were used to test the proposed method's performance.

The example of the test images is shown in Picture 3 The A-type has an average width of 24.25 mm and an average height of 66.50 mm, whereas the B-type has an average width of 22.00 mm and an average height of 64.50 mm.

A-type   B-type
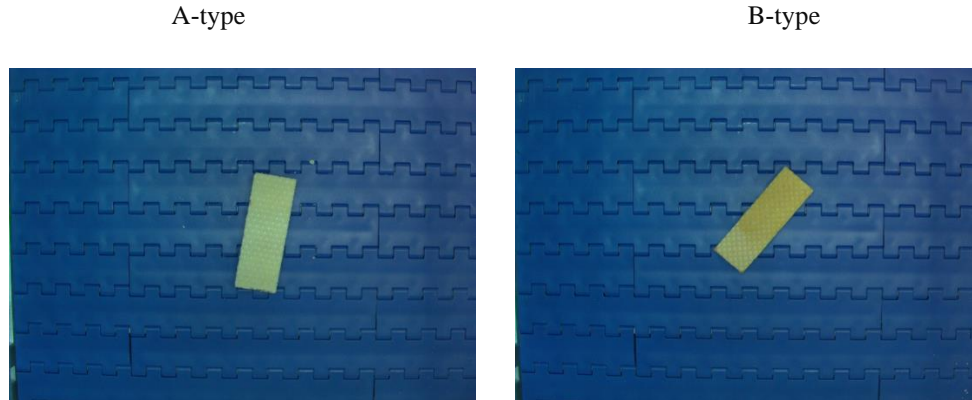
Picture 3: Example of two types of testing images A-type and B-type

1. **Optimization of Thresholding Value based on Golden Section Search**

In this experiment, the number of input B-type images was varied to 6, 12, and 24 images with 1.0 standard deviation Gaussian noise. For golden section search, the maximum number of iterations to perform and the tolerance to stop the process are set to 100 and $1.490×10^{-8}$, respectively. In addition, the computing time of each experiment was tested to ensure that the proposed method worked properly. Picture 4 illustrates the RMS error of the optimization process with varying numbers of input images, indicating that the converge time of each test is quite identical. What is interesting in Table 1 is the similarity of thresholding value optimized by the proposed method. Despite changing the amount of input images, the thresholding values of 3 scenarios were all around 126. However, when the number of input images increases, the computational time is longer.
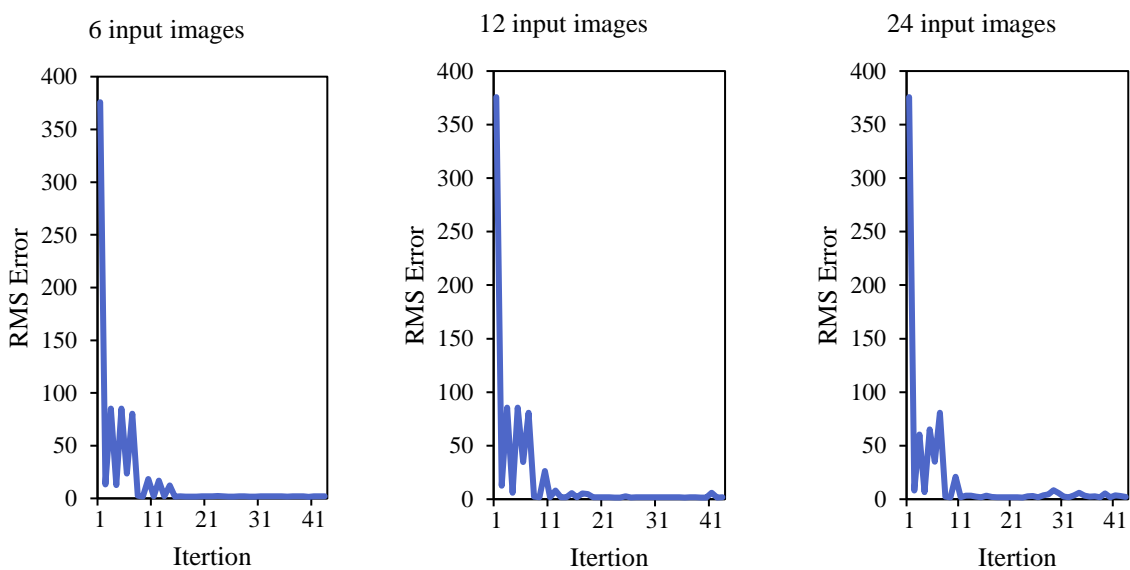
**Picture 4:** The comparison of RMS Error and number of input images

Table 1: Results of thresholding value optimization value based on golden section search

Number of input images	Thresholding value	Computational time (s)
6	126.7033	54.077
12	126.3799	108.659
24	126.3932	212.085

2. Object Size Measurement

In this experiment, 48 images of both types with varied Gaussian noises were evaluated by the proposed method (SMM). The method was applied to 48 images with different Gaussian noises for each test. To evaluate the algorithm's robustness, the standard deviation (σ) of Gaussian noise is increased by 0.5 until it reaches 2.0, as shown in Picture 5. The calculations of RMS error and standard deviation are utilized to measure the performance of the method. The performance of the proposed method will be compared with the size measuring method based on the bounding box (SMB) and the size measuring method based on average value (SMA).
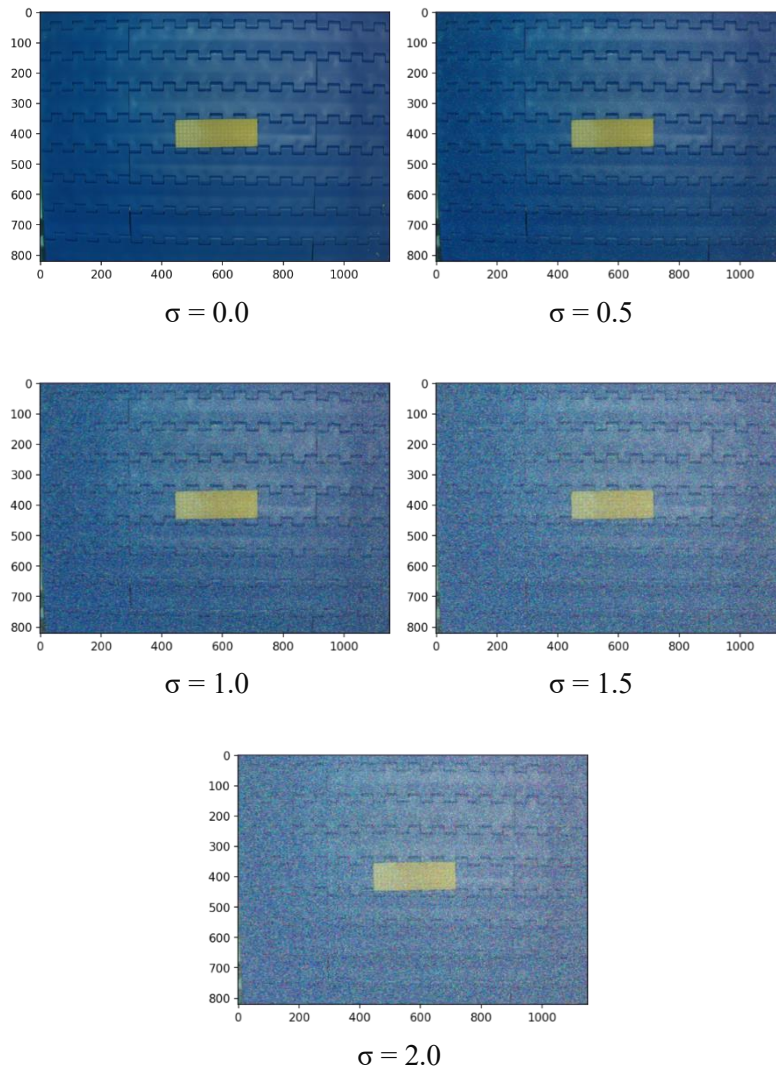

Picture 5: Example of testing images with different standard deviation of Gaussian noise
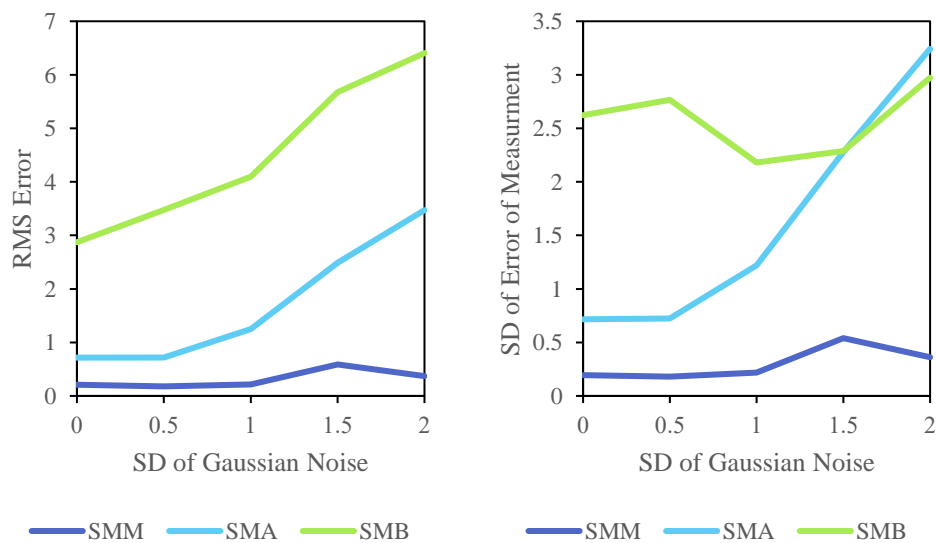
2.1 Experiment with A-type images

From the benchmark, the errors of measurements with different Gaussian noise are shown in Picture 6. The errors of the SMM method are likely to be zero in all scenarios tested with varied Gaussian noise, whereas the errors of the SMA and SMB are affected by the Gaussian noise. The comparison of RMS error and standard deviation of errors in Picture 7 shows that the suggested SMM technique produces a lower error as well as less error distribution.
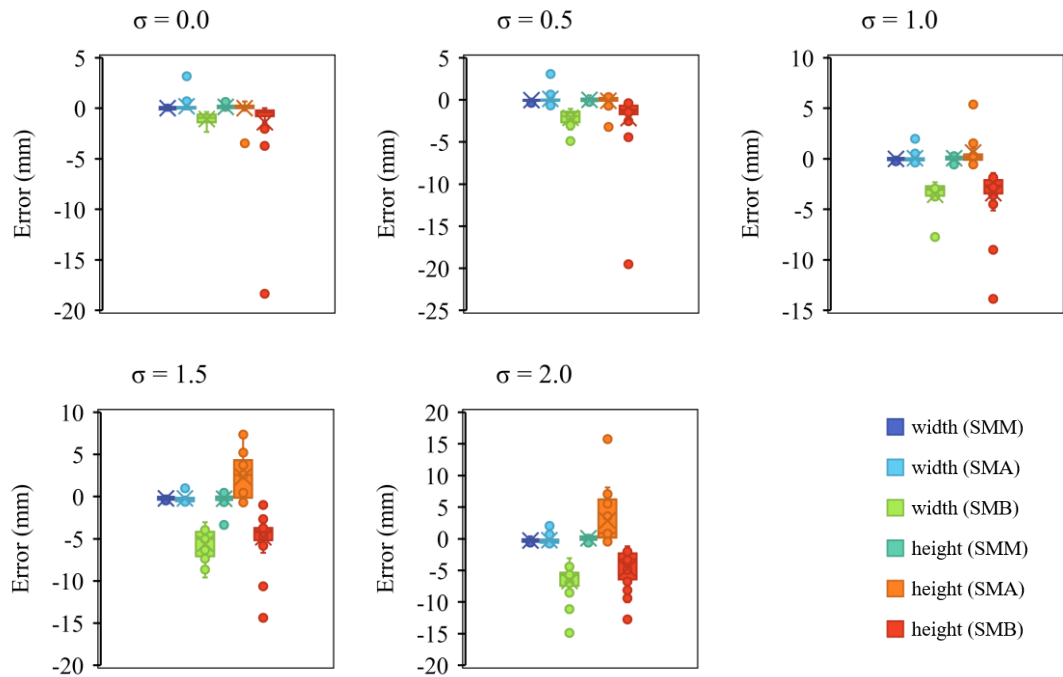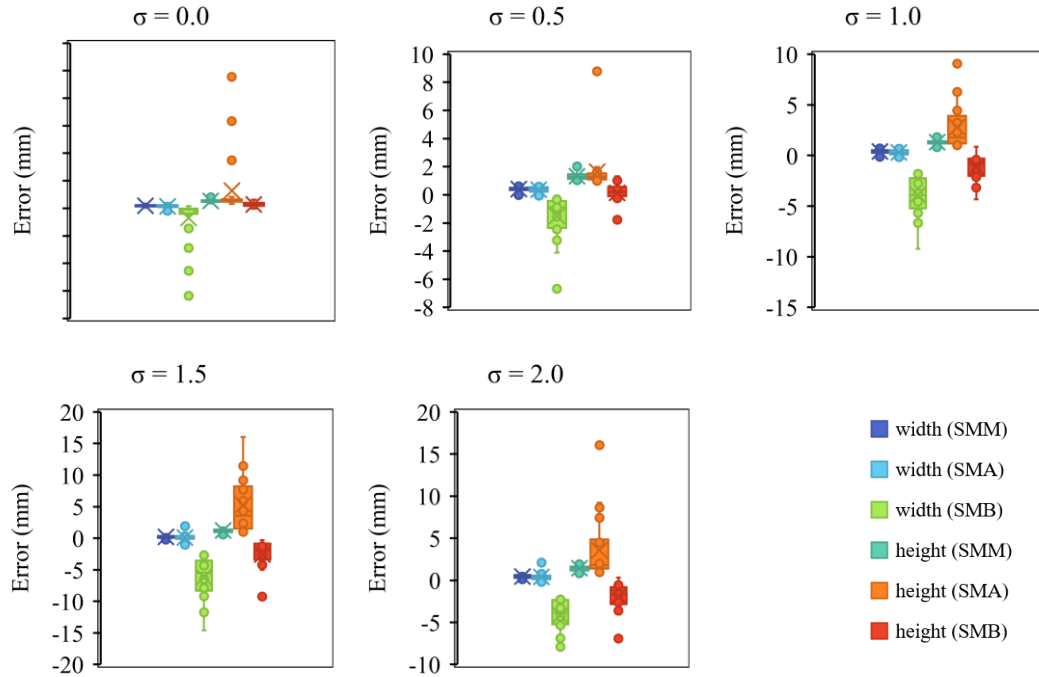

**Picture 6:** Error of measurements in width and height of A-type images

Picture 7: RMS error and standard deviation of error of A-type experiments

2.2 Experiment with B-type images

The results shown in Pictures 8 and 9 in this experiment are the same as those tested in the earlier experiment. The proposed SMM approach yields the best results, however, the errors in object height are slightly higher than zero. RMS error and standard deviation of the SMM method are, as a result, near 1 and 0.5, respectively.

Picture 8: Error of measurements in width and height of B-type images
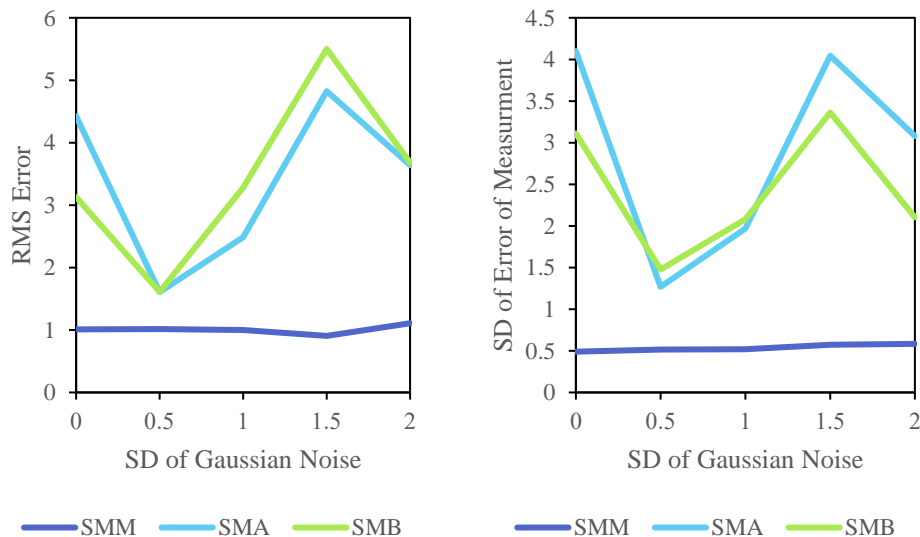
Picture 9: RMS error and standard deviation of error of B-type experiments

Discussion

The experimental results in the previous section can be divided into three main key points which are the optimization of thresholding value, the sizing error of measurements, and the comparison with

conventional methods. In the optimization benchmark, it can be concluded that the amount of images used in the optimization process will not affect the optimal solution as the thresholding values from 3 tests are quite similar. The error of measurement benchmark results suggests that the proposed SMM method is acceptable for size measurement because the error of measurement is close to zero even when image noise is increased. What stands out in the comparison benchmark is the performance of the proposed method compared to SMA and SMB methods. Because of the difficulty in determining the number of pixels, the RMS error and standard deviation of both types of images produced by the SMM method are lower than those produced by the SMA and SMB methods. When the Gaussian noise is increased, the SMA and SMB methods produce more errors because they are unable to determine the exact number of pixels to calculate the actual size of an object. Therefore, it appears that the proposed method for determining the size of objects is feasible. One restriction is that the colors of the items and the background must be different. When both colors are close, it is difficult to distinguish the object from the background. In order to employ the proposed method, the size information of sample images must be given in advance so that it can be used in the optimization process.

Conclusion

The paper focuses on the method to inspect the dimensions of food products. This method inspires by the concept of basic image processing called the thresholding method. The threshold method is a type of segmentation method to select areas of interest in an image. However, it is difficult to select the appropriate thresholding value. Therefore, the golden section search method is contributed to solving the problem to find a tuning thresholding value. The concept of the golden section search is finding the threshold values by using the golden ratio method. Then reprocess until gains the appropriate value to separate the product image from the background. The results of finding the optimized thresholding value over the number of product images show that number of images is not affected the results of the golden section search. This means the method does not need a large number of images to find the optimized thresholding value. The section experiments also show the quality of segmentation by using this method over a noise environment. The method can overcome the noise in the images which come from the environment or equipment. The final results show the accuracy of the method compared to the conventional methods. The golden section search gave a small error of measurement result compared to other methods. Despite the fact that the golden section search yields positive results, the studies were only conducted on rectangular food products with different colors than the conveyor. Therefore, the method should be developed to measure the different shapes of the product.

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DEVELOPMENT OF NEW HEALTHY BEVERAGES FROM KARANDA (*Carissa carandas L.*) FRUITS AND KALE

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Abstract

The objective of this research was aimed to develop new healthy beverages from karanda fruits (*Carissa carandas L.*) and kale as local raw materials, and study the product shelf life & target consumer acceptance (18-60 years) at Panyapiwat Institute of Management. The sensory evaluation by using 100 target consumers has conducted the sample with a sensory test and questionnaire.

The results from selecting the 4 basic formulations of healthy beverages from karanda fruits and kale (formulation 1-4 at the ratio of kale and karanda fruits at 0:100, 25:75, 50:50, and 75:25, respectively) with different amounts of karanda fruits and kale showed that the best formulation was 25:75 of the ratio between karanda fruits and kale. This formulation was the highest liking scores including appearance (7.33+1.45), color (7.30+1.66), flavor (6.70+1.91), taste (6.70+1.90, sweetness (6.23+1.61), sourness (6.90+2.55) and overall liking (6.93+1.53). Hence, the selected basic formula was developed according to the formula by using the beverage products that received the highest ratings to adjust the formula to choose the best formula, all 4 formulas: formulation 1 sugar, formulation 2 sucralose, formulation 3 sugar with xanthan gum, formulation 4: sucralose with xanthan gum. From the experiment to develop healthy drink products karanda fruits and kale, the results found that formulation with sugar and no stabilizer (xanthan gum) was separated and sedimented while the formulated with sucralose and xanthan gum was not separated and had no sedimentation. These developed healthy beverages had a shelf-life of 4 days. Therefore, the formulated sucralose with xanthan gum was the best attribute sample and highest consumer liking. The developed health drink from karanda fruits and kale received a moderate level of liking scores (7.11+0.30). 83% of consumers accepted the product and 92% of consumers were purchase intent.

Keywords: Karanda Fruits, Kale, New Healthy Beverages, and Karanda Fruits and Kale

Introduction

Nowadays, consumer interest in healthier diets is changing into healthy beverage innovation, with functional drinks and alcohol alternatives. Both added sugars and artificial sweeteners were increased concern by consumers. The UK's Food Standards Agency, for example, found in 2018 that the proportion of consumers worried about sugar had increased from 39% in 2010 to 55%. They are concerned in parallel that beverage makers have moved toward more low/no/and reduced sugar claims. However, sugar and sweeteners are top concerns (Fi Global Insights, 2022). The changing lifestyles and altering eating patterns of the consumers have resulted in increased consumption of available, healthy, and quick sources of nutrition like packaged fruit juices, thereby increasing the growth of the market. The global marketing of fruit juice showed a value of US$ 141 Billion in 2021. In 2017, the market for fruit juice was guessed at US$ 182 Billion by 2027, presenting a CAGR of 4.31% from 2022-to 2027 (Fi Global Insights, 2022).

The consumer needs fruit juice that is non-fermented and minimally processing. Many different types of fruit juice offered varied health benefits, such as avocado juice boosts natural energy in the body; watermelon juice helps the body hydrated and improves metabolism; papaya juice supports healthy digestion; lemon juice fights viral infections, and pineapple juice reduces cholesterol levels. This, coupled with the refreshing taste and health benefit of fruit juice, makes it one of the most widely consumed beverages across the globe (GlobeNewswire, 2022). To expand the consumer base, manufacturers are introducing a wide array of flavors and producing preservative-free and sugar-free fruit juices. In addition to this, growth in the food and beverage industry is boosting the overall demand for fruit juices worldwide.

Presently, interest in developing functional foods for nutrition and disease prevention has continuously increased, with increased consumer demand for fruits and their products such as juice. This research investigated healthy beverage development from karanda fruit and kale

Karanda (*Carissa carandas L.*) (in Thai called naming or manaao ho), is a tropical plant that belongs to the Apocynaceae family and is likely related to Carissa spinarum L. Karanda fruit is a good source of vitamin C, phenolic compounds, anthocyanins, and minerals especially iron, calcium, and phosphorus. The whole karanda plant, which contains high nutrition can be used as traditional medicine. Moreover, karanda fruit had biological properties that include antidiabetic, antimicrobial, cytotoxicity, hepatoprotective, and anti-inflammatory. Karanda fruit can be a good appetizer and is often used to make pickles, jelly, jam, squash, syrup, tarts, and chutney. There are many local products made from karanda fruits including juice, jam, and desserts in Thailand (Rumjuankiat et al., 2018). The unripe carandas fruit extract showed high content of phenolic content and elastase inhibition of the fresh fruit in the fully ripe stage was 100.31 ± 2.64 mg GAE/g extract and $14.11\% \pm 0.95\%$, respectively. The fresh fruit in the unripe stage showed that the strongest percentage of DPPH IC50 and collagenase inhibitory activity were 29.11 ± 0.23 µg/mL and $85.94\% \pm 2.21\%$, respectively (Khuanekkaphan et al., 2021).

Kale is a green leafy vegetable that belongs to the brassica family, a group of vegetables including cabbage, collards, and brussels sprouts. Kale has recent widespread attention due to its health-promoting, sulfur-containing phytonutrients. It is easy to grow and can grow in colder temperatures. The leaves of kale can be curly and quite ornamental, but they become too tough to eat fresh, as they mature. Kale is a member of the cabbage family and is susceptible to many of the pests that attack the cabbage family. Its Latin name is Brassica oleracea. Kale was found to be a good source of vegetable protein (11.67%) and fiber (3.0%). The else proximate parameters include; moisture (81.38%), ash (1.33%), fat (0.26%), carbohydrate (2.36%) and energy (58.46 kcal/100 g). Observed mineral content were: sodium (4.69 mg/100 g), potassium (7.03 mg/100 g), calcium (4.05 mg/100 g), iron (8.94 mg/100 g), zinc (2.16 mg/100 g) and magnesium (6.69 mg/100 g). Kale (*Brassica oleracea var. acephala*) has a high potential as a vegetable in the preparation of different Nigerian dishes and treatment of various diseases due to its nutritional potential (Emebu & Anyika, 2011).

This research, conducted an experiment and ways to develop new healthy beverages from karanda fruits (*Carissa carandas L.*) and kale to fit the healthy target consumer needs.

Research Objectives

1. To investigate the basic formulation of new healthy beverages from karanda fruits and kale
2. To develop new healthy beverages from karanda fruits and kale
3. To investigate the consumer liking and acceptance of new healthy beverages from karanda fruits and kale
4. To investigate the shelf life of new healthy beverages from karanda fruits and kale

Literature Review

The functional beverage market trend in 2022 includes energy drinks, fortified juice, sports drinks, and dairy and dairy alternative drinks is found. Others in this category are enhanced water products, ready-to-drink tea, and coffee. The global functional beverage market is forecasted to grow at a compound annual growth rate of 8.66% from 2019-to 2024. Health awareness is increased the yoin ung population driven by moving from fruit juices and carbonated drinks to functional beverages. Additionally, consumers also have demonstrated that they are willing to pay higher prices to gain the advantages associated with these drinks (Linchpinseo, 2022).

The karanda fruit has ascorbic acid (9-11 mg/100g) lower than orange (37.4 mg/100g) while karanda fruit had higher antioxidant activity than orange. The karanda fruit (Carissa carandas L.) was reported to contain 83.17-83.24 g of moisture, 0.39-0.66 g protein, 2.57-4.63 g fat, 0.51-0.94 g carbohydrates, and 0.62- 1.81 g fiber per 100 g of fresh fruit. The reported nutritional information per 100 g of edible fruit is a source of: 42.5 kcal energy, 0.39-1.1 g protein (negligible), 2.5-4.63 g fat, 0.51-2.9 g carbohydrate, 0.62-1.81 g fiber, 21 mg calcium, 28 mg phosphorous, 1619 IU vitamin A, and 9-11 mg ascorbic acid (Singh and Uppal, 2015).

The extraction of anthocyanin colorant from karanda fruit was carried out and optimized with multiple single-factor assays. Selected conditions for yield maximization consisted of ripening fruits with black-purple color, material size of thin slices (1.0–1.5 mm), the solvent of EtOH 50%, material/ solvent ratio of 1:3, the temperature of 50 ∘C, extraction time of 45 min, and two extraction cycles. The anthocyanin content in the extract was 277.2 mg/L, which is equivalent to 9.33 mg of anthocyanin per gram of dry material. The anthocyanin content increased corresponding to the maturity level of Carissa carandas fruits. As can be seen from the figure, although with perfectly ripe fruits, the level of anthocyanin reached the highest point of 13.65 mg/g, our acquaintance and experiments with the fruit advised that Carissa carandas fruits at this stage are difficult to harvest and preserve due to its vulnerability to damage. Therefore, the ripened fruits should be used for anthocyanin extraction (Le et al., 2019).

Kale (Brassica Oleracea Acephala Group) is a green leafy vegetable with high content of nutraceuticals. The content of the bioactive compounds of kale is affected by the cultivar, and thus it is necessary to identify kale cultivars that have the highest nutritional content, to promote their consumption. Serving the size of kale gives more than 100% of the recommended daily intake (RDI) of vitamin A and more than 40% of the RDI of vitamin C. Thus, kale can be considered an excellent source of antioxidants (Morenoa et al., 2013).

The healthy beverages from karanda fruits (Carissa carandas) and kale were very interesting because that was new healthy beverages and these healthy beverages haven't been found on the market yet.

Pasteurization with a temperature of 70°C at 15s is one of the processes for new healthy beverages production from karanda fruits and kale to kill any bacteria or other microorganisms that may be present. Pasteurized beverages from karanda fruits and kale have been heated to high temperatures for a short time in the process. Harmful bacteria may be present and become part of the finished beverage when fruits and vegetables are made into fresh-squeezed juice (Jeannie, 2014). The karanda fruits and kale juice have a pH below 4.6 which is an important action to inhibit the growth of most pathogenic microorganisms as a barrier, preserving the beverage (Silva et al., 2007).

Xanthan gum is a polysaccharide that is mostly used in many industries such as a common food additive to thickening agent, emulsifier, and stabilizer. Adding xanthan gum to beverage can prevent ingredients from separating, therefore the development of healthy beverages from karanda fruits and kale is used by adding xanthan gum in the formulation.

Normally juice processing, acidified juice was thermally processed in a plate heat exchanger composed of regeneration, heating, holding, and cooling sections. The research of Kunitake et al. (2014) revealed that the juice processing with a plate heat exchanger was capacity at 300 L/h and the pasteurization binomials were 72°C for 15s. The juice was filtered, preheated to a temperature of about 50 °C, homogenized at 150 Bar in a single-stage homogenizer, heated to the pasteurization temperature, cooled to approximately 8°C, and pumped to an insulated buffer tank. The stainless steel with ISO Class 5 unidirectional air-flow cabin was conducted for the beverage's aseptic filling into transparent 320 mL PET bottles, which were previously decontaminated by dipping in a 0.05% (v/v) peracetic acid (PAA) solution at 50 °C for 30 min (Kunitake et al., 2014).

The mixing of karanda fruits and kale affected beverage taste and color. Hence, the present project's objective was to evaluate the appropriate formulation and know the shelf-life of healthy beverages to fit the target consumer's needs.

Methodology

    1. Selection of basic formulation of new healthy beverages from karanda fruits and kale

The 4 basic formulations of new healthy beverages from karanda fruits and kale were selected for the product prototype. The formulation of kale juice was prepared by using kale and water in a ratio of 1:3. Then, the optimization ratio between karanda fruits and kale juice was studied in the ratio at 0:100, 25:75, 50:50, and 75:25, respectively.

The healthy beverage production was cutting the karanda fruits and a half separating and outing the seeds. Then soak in 5% saline for 30 minutes to wash off the rubber before pouring out the water rinse with clean water accordingly. The 2400 g of water in the pot was boiled, then karanda fruits were put in the pot until it boils. The 500 g of sugar and 1 g of salt was added to help the taste. Continuously boiling with 100°C for 15 minutes was conducted, then straining out the meat was processed. The healthy beverages were immersed in an ice bath to bring the temperature down to below 15°C. The 4 karanda fruits formulations were mixed with cold-pressed kale juice and packed in sterile glass vials. Finally, the healthy beverages from karanda fruits and kale were kept at 0-4°C before further analysis.

The 4 formulations of healthy beverages with a ratio between karanda fruits and kale juice in the ratio at 0:100, 25:75, 50:50, and 75:25 were studied in the appropriate ratio and then all samples were analyzed for sensory evaluation as followed:

    1.1 Sensory evaluation

Sensory evaluation was conducted using 50 untrained panelists as target consumer who was asked to score appearance, color, flavor, sweetness, sourness, and overall liking on a 9-point hedonic scale ranging from 1 (extremely dislike) to 9 (extremely like) and JAR (just about right) scale for each sensory attribute. (Feng and Mahony, 2017). The target consumer was 18-60 years old and liked to drink healthy beverage was conducted at Panyapiwat Institute of Management in partitioned sensory booths and evaluated questionnaire.

    1.2 Statistical and data analysis.

All data were presented as the mean ± standard deviation and analysis of variance was determined. A confidence level of 5% was used to compare means ($P>0.05$) between treatments. The mean values were compared using Duncan's New Multiple Range Test (DMRT) procedures. Statistical analysis of results was performed using an SPSS package (SPSS 12.0 for Windows, SPSS Inc., Thailand).

2. **Development of new healthy beverages from karanda fruits and kale**

The developing 4 treatments to decrease calories and improve formulation using Completely Random Design (CRD) design including treatment1: sugar and no xanthan gum, treatment2: sucralose and no xanthan gum, treatment3: sugar and xanthan gum, and treatment4: sucralose and xanthan gum and then all samples were selected the best treatment form analyzing the quality including chemical property and sensory evaluation as followed:

2.1 The chemical property of new healthy beverages from karanda fruits and kale

The determination of vitamin C content in beverages was determined by direct titration with iodine. Every 25 ml of the beverages was transferred into a 250 ml Erlenmeyer flask. The 25 ml of 2 N sulfuric acids were added, mixed, diluted with 50 ml of water, and then, 3 ml of starch T.S. was added as an indicator. The solution was directly titrated with 0.1 N iodine previously standardized with primary standard arsenic trioxide. A blank titration was performed before titration of each sample (n=5). Each ml of 0.1 N iodine is equivalent to 8.806 mg ascorbic acid (Suntornsuk et al., 2002).

The pH values of all samples were monitored using a pH meter (Docu-pH-Meter; Sartorius; Goettingen, Germany) described in Hjalmarsson et al. (2007).

2.2 The physical property of new healthy beverages from karanda fruits and kale

The color of the peptide powder was evaluated using a spectrophotometer (CM-3500d; Minolta Co.; Tokyo, Japan) and reported as L* (whiteness/darkness), a*(redness/greenness), and b* (yellowness/blueness) as defined by CIE (1986). The lowest value of L* (0) indicates the darkest while the maximum value (100) indicates the brightest white. The a* value (green-red color) is negative for green and positive for red. The b* value (blue-yellow color) is negative for blue and positive for yellow. A white standard board was used for calibration. Each sample had five replications.

2.3 Sensory evaluation of new healthy beverages from karanda fruits and kale

Sensory evaluation using 60 untrained panelists as target consumers was studied. Target consumers were asked to like score appearance, color, flavor, sweetness, sourness, and overall liking on a 9-point hedonic scale ranging from 1 (extremely dislike) to 9 (extremely like) and JAR (just about right) scale for each sensory attribute (Feng & Mahony, 2017).

2.4 Statistical and data analysis.

All data were presented as the mean ± standard deviation and analysis of variance was determined. A confidence level of 5% was used to compare means ($P<0.05$) between treatments. The mean values were compared using Duncan's New Multiple Range Test (DMRT) procedures. Statistical analysis of results was performed using an SPSS package (SPSS 12.0 for Windows, SPSS Inc., Thailand).

3. **Investigation of the consumer liking and acceptance of new healthy beverages from karanda fruits and kale**

The 100 untrained panelists (target consumer), 18-60 years old was conducted at Panyapiwat Institute of Management in partitioned sensory booths and evaluated questionnaire dived into 2 parts as followed:

Part1: Questionnaire on the topic of consumer demographics (sex, age, education, career, income)

Part2: Consumer liking and acceptance of new healthy beverages from karanda fruits (Carissa carandas) and kale

For sensory evaluation, 100 untrained panelists used to determine the appearance, color, flavor, sweetness, sourness, and overall liking on a 9-point hedonic scale ranking from 1 (extremely dislike) to 9 (extremely like) (Feng & Mahony, 2017) and consumer acceptance on developed healthy beverage from karanda fruits and kale (appropriate price and purchase intent). The population size design of this study used consumer acceptant tests that provided a sample size of 60 or more for power

calculations conducted following the method of ISO 8587: 2006 on the topic of sensory analysis - methodology - ranking (Birol, Meenakshi, Oparinde, Perez, & Tomlins, 2015).

4. Investigation of the shelf life of new healthy beverages from Karanda fruits and kale

The shelf life of 4 treatments of new healthy beverages from karanda fruits and kale was studied. The 4 formulations were stored at 0-4°c in a refrigerator and randomly sampled for sensory testing daily. It was stopped sensory testing when new healthy beverages from karanda fruits and kale received an overall liking score of fewer than 5 points and had a physicochemical quality that indicated deterioration, it was terminated the sensory test. Each sensory evaluation involves 30 untrained panelists asking about the product's sensory characteristics: appearance, color, flavor, sweetness, sourness, and overall liking.

Results and Discussion

1. Selection of basic formulation of new healthy beverages from karanda fruits and kale

For sensory characteristics, the determination was performed and expressed in terms of the overall acceptable score (Table 1). The result of sensory evaluation revealed that the ratio of kale and karanda fruits affected the consumer liking score, and resulted in the highest appearance (7.33), color (7.30), flavor (6.70), taste (6.70), sweetness (6.23), sourness (6.90) and overall liking score (6.93) in 25:75 of the ratio of kale and karanda fruits (P<0.05). For 0:100 of the ratio of kale and karanda fruits, this treatment had the second sourness (6.57) and overall liking score (6.07) after the 25:75 ratio. The increase in kale level impacted on stinky green taste that the consumer didn't like the taste, and therefore increase in kale level affected the decrease of consumer liking score. Hence, the treatment of 25:75 (ratio of kale and karanda fruits) was the best treatment and could be used as a basic formulation to develop in the next experiment.

Table 1: Sensory evaluation of new healthy beverages from karanda fruits and kale with varied ratio

Attribute	0:100	25:75	50:50	75:25
Appearance	$5.60^b \pm 1.92$	$7.33^a \pm 1.45$	$5.43^b \pm 2.33$	$5.70^b \pm 1.68$
Color	$5.77^b \pm 1.99$	$7.30^a \pm 1.66$	$5.70^b \pm 2.41$	$5.43^c \pm 1.74$
Flavor	$5.20^b \pm 2.31$	$6.70^a \pm 1.91$	$4.07^d \pm 1.72$	$4.62^c \pm 2.04$
Taste	$5.57^b \pm 1.98$	$6.70^a \pm 1.90$	$4.33^d \pm 1.58$	$5.07^c \pm 1.87$
Sweetness	$5.97^b \pm 1.94$	$6.23^a \pm 1.61$	4.23 ± 1.50	$5.63^c \pm 1.99$
Sourness	$6.57^b \pm 2.55$	$6.90^a \pm 2.55$	$6.77^{ab} \pm 2.11$	$6.63^b \pm 2.46$
Overall acceptable	$6.07^b \pm 2.12$	$6.93^a \pm 1.53$	$4.80^d \pm 1.99$	$5.50^c \pm 2.06$

Remarks: 0:100, 25:75, 50:50, and 75:25 means the ratio of kale and karanda fruits
[a-c] Means within the same row with different letters are significantly different (*P*<0.05).

Table 2: JAR (just about right) scale of new healthy beverages from karanda fruits and kale with varied ratio

Treatment	Attributes	Too little	JAR	Too much
0:100*	Color	20	60	20
	Flavor	10	56.7	33.3
	Taste	10	70	20
	Sweetness	13.3	70	16.7
	Sourness	0	0	0

Table 2: JAR (just about right) scale of new healthy beverages from karanda fruits and kale with varied ratio (Cont.)

Treatment	Attributes	Too little	JAR	Too much
25:75*	Color	3.3	86.6	10.0
	Flavor	6.7	80.0	13.3
	Taste	6.7	66.7	26.7
	Sweetness	3.3	63.3	33.3
	Sourness	5.3	77.7	17.0
50:50*	Attributes	Too little	JAR	Too much
	Color	23.3	60	16.7
	Flavor	16.7	36.67	46.7
	Taste	20	43.33	36.7
	Sweetness	23.3	70	6.7
	Sourness	26.7	53.3	20
75:25*	Attributes	Too little	JAR	Too much
	Color	13.3	63.3	23.3
	Flavor	13.3	23.3	63.3
	Taste	16.7	33.3	50
	Sweetness	60	30	10
	Sourness	23.3	26.7	50

Remarks: 0:100, 25:75, 50:50, and 75:25 means ratio of kale and karanda fruits

The higher 70% Just About Right (JAR) of 25:75 (the ratio of kale and karanda fruits) with all attributes (color, flavor, taste, sweetness, oiliness, and texture (homogeneously) resulted in Table2. Hence, this treatment was suitable for the development of new healthy beverages from karanda fruits and kale to fit target consumer needs.

2. Development of new healthy beverages from karanda fruits and kale

From the selected basic formulation (25:75 ratio of kale and karanda fruits), the development in 4 treatments to decrease calories and improve formulation including treatment1: sugar and no xanthan gum, treatment2: sucralose and no xanthan gum, treatment3: sugar and xanthan gum, and treatment4: sucralose and xanthan gum was studied.The chemical attributes were measured in terms of vitamin C content in beverages as shown in Table 3. The research of Pewlong et al. (2014) revealed that the unripe fruit extract showed the highest content of vitamin C (300.75±57 mg/100g) while kale had vitamin C (62.27 mg/100g) to the research of Sikora and Bodziarczyk (2012). This result occurred from karanda fruits and kale was the source of high vitamin C, thus, new beverages from karanda fruits and kale had high vitamin C in the range of 118-122 (mg/100g) expressed in Table 3. The content of vitamin C in Table 3 was different compared to the research of Sikora and Bodziarczyk (2012) because of the mixing of karanda fruits (high vitamin content source) and kale (low vitamin content source) affected vitamin C content in formulation lower than pure karanda fruits. The treatmet4 had the highest vitamin C content (122 mg/100g) because this treatment was added to xanthan gum with sucralose. The results could explain that xanthan gum enriched with ascorbic by coatings polyphenol oxidase, ascorbic acid oxidase, polymethyl etherize acitivies and maintaned the structural integrity of the new healthy beverages from karanda fruits and kale (Golly et al., 2019). All treatments of new healthy beverages from karanda fruits (Carissa carandas) and kale had a pH below 4.6 ($P \geq 0.05$) which was an important

action to inhibit the growth of most pathogenic microorganisms as a barrier, preserving the beverage (Silva et al., 2007). The pH value was not significantly different ($P \geq 0.05$) because sucralose and xanthan gum didn't effect on hydrogen ion reaction in the formulation.

Table 3: Chemical property (Vitamin C and pH) of new healthy beverages from karanda fruits and kale

Chemical property	Treatment1	Treatment2	Treatment3	Treatment4
Vitamin C (mg/100g)	118[c]±0.10	118[c]±0.05	120[b]±0.08	122[a]±0.12
pH[NS]	4.50±0.55	4.52±0.46	4.50±0.60	4.52±0.58

[NS] Means within the same row are not significantly different ($P \geq 0.05$).
[a-c] Means within the same row with different letters are significantly different ($P < 0.05$).

The results show that treatment 2 (sucralose and no xanthan gum) had the highest L*, a*, b*. This phenomenon could explain that sucralose affected on brightening color by providing a bright red beverage while the use of xanthan gum did not affect the color as showing no significantly different in treatment 1 (sugar and no xanthan gum) and treatment 3 (sugar and xanthan gum) (P<0.05) because xanthan gum had clear white and using quite a bit of xanthan gum in the formulation as shown in Table 4.

Table4: Color (L*, a*, b*) of new healthy beverages from karanda fruits (Carissa carandas) and kale

Treatment	L*	a*	b*
1	18.84[b]±0.07	12.97[b]±0.04	12.18[b]±0.04
2	19.68[a]±0.32	16.32[a]±0.74	15.33[a]±1.63
3	19.15[ab]±0.61	12.54[b]±0.26	12.40[b]±0.15
4	18.63[b]±0.01	12.74[b]±0.06	12.19[b]±0.01

[a-b] Means within the same row with different letters are significantly different ($P < 0.05$).

Table 5: Sensory evaluation of new healthy beverages from karanda fruits and kale with varied ratio

Attribute	Treatment1	Treatment2	Treatment3	Treatment4
Appearance	6.90[b]±0.74	6.90[b]±0.74	7.80[a]±0.63	7.90[a]±0.88
Color	5.90[b]±0.74	5.60[b]±0.70	7.40[a]±0.52	7.90[a]±0.88
Flavor	5.40[b]±0.52	7.50[a]±0.53	5.50[b]±0.53	7.80[a]±0.79
Sweetness	5.50[c]±0.71	7.40[b]±0.52	5.80[c]±1.55	8.50[a]±0.53
Sourness	5.50[b]±0.92	7.30[a]±0.48	5.90[b]±0.74	7.92[a]±0.74
Overall liking	5.70[c]±0.48	6.80[b]±0.42	7.00[b]±0.67	8.20[a]±0.63

[a-c] Means within the same row with different letters are significantly different ($P < 0.05$).

From Table 5, the sensory evaluation of beverages using sugar and sucralose and xanthan gum on varied treatments in formulation resulted in different consumer likings. The use of xanthan gum gave the beverage a homogeneously color, resulting in a higher color score than the non-xanthan gum sample as shown in the higher color score in Treatment3 and 4 than Treatment1 and 2. Treatment 4 (adding sucralose and xanthan) had the highest appearance (7.90), color (7.90), flavor (7.80), sweetness (8.50), sourness (7.92), and overall liking (8.20). Hence, treatment 4 was selected to study consumer liking and acceptance next step.

3. Investigation of the consumer liking and acceptance of new healthy beverages from karanda fruits and kale

Table 6: Demographics information of new healthy beverages from karanda fruits and kale

Demographics	%
Sex	
Male	27
Female	73
Age	
18 – 30 years	91
31 – 45 years	9
46 – 60 years	0
Education	
Lower than Bachelor	9
Bachelor	82
Higher than Bachelor	9
Career	
Student	73
Company employee	18
General employee	9
Income	
Lower than 5,000 THB	9
5,001 - 10,000 THB	64
10,001 -20,000 THB	18
Lower than 30,001 THB	9

From the Table 6, The results of the questionnaire with 100 untrained panelists (target consumers) showed that most of the consumers were female (73%), 18-30 years (91%), with a bachelor's degree (82%), student (73%), and had 5,001-10,000 THB income (64%).

Table 7: Consumer Behaviors and Needs of new healthy beverages from karanda fruits and kale

Consumer Behaviors and Needs	%
Frequency of purchase	
More than 4 times per week	27.3
2 – 4 times per week	54.5
1 times per week	18.2
Popular time to buy healthy beverage	
06.00 – 09.00 AM	8.3
09.01 – 12.00 AM	8.3
01.00 – 03.00 PM	16.7
03.01 – 06.00 PM	41.7
06.01 – 09.00 PM	25
Popular place to buy healthy beverage	
7-11	83.3
Max value	16.7
Lemon Farm	0
Foodland	0
Top Supermarket	0

From the Table 7, The results of the questionnaire with 100 untrained panelists (target consumers) showed that most of the consumers had a frequency of purchase at 2-4 times per week, a popular time to buy a healthy beverage at 3.01 – 6.00 PM and 7-11 as a popular place to buy a healthy beverage.

Table 8: Consumer acceptant of developed new healthy beverages from karanda fruits and kale

Question	Yes (%)	Undecided (%)	No (%)
Product acceptance	92	4	4
Purchase Intention	83	11	6

The consumer acceptance of developed new healthy beverages from karanda fruits kale was accepted by 92% of the target consumer, and 83% of the purchase intention. For undecided consumers they developed new healthy beverages from karanda fruits (Carissa carandas) and kale, they suggested providing more information on health benefits, price, and packaging design as shown in Table 8.

Table 9: Suitable price of developed new healthy beverages from karanda fruits and kale at size of 250 ml

Price	%
35 THB	25
39 THB	33.3
46 THB	16.7
59 THB	25

From Table 9, the result showed that the consumer need for a suitable price of developed new healthy beverages at a size of 250 ml was 39 THB (33.3%).

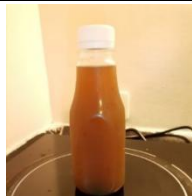**Table 10:** Consumer liking of developed new healthy beverages from karanda fruits and kale

Attribute	Developed new healthy beverages
Appearance	7.56 ± 0.5
Color	6.56 ± 1.2
Flavor	7.56 ± 1.3
Taste	7.89 ± 0.3
Sweetness	6.67 ± 1.6
Sourness	7.89 ± 0.6
Overall liking	7.11 ± 0.3

The sensory attributes in terms of appearance, color, flavor, taste, sweetness, sourness, and overall liking are measured. This data was used to show consumer liking of developed new healthy beverages. The sensory attributes in terms of liking score show that developed new healthy beverages from karanda fruits and kale had an appearance at 7.56±0.50 (moderate liking), color at 6.56±1.20 (slight liking), flavor at 7.56±1.30 (moderate liking), taste at 7.89±0.30 (moderate liking), sweetness at 6.67±1.60 (slight liking), sourness at 7.89±0.60 (moderate liking) and overall liking at 7.11±0.30 (moderate liking), respectively (Table 10).

4. Investigation of the shelf life of new healthy beverages from karanda fruits and kale

The shelf life of 4 treatments of new healthy beverages from karanda fruits and kale was studied. The 4 formulations were stored at 0-4°c in a refrigerator and randomly sampled for sensory testing daily as shown in Table 10.

Table 10: Shelf-life of 4 treatment of new healthy beverages (7 days)

7 Days	**Treatment 1: sugar and no xanthan gum** The karanda fruits and kale blended with sugar were changed, with slight pinkish precipitation beginning to occur from the separation of the karanda fruits and kale without air bubbles.	**Treatment 2: sucralose and no xanthan gum** The karanda fruits and kale mixed with sucralose were changed, beginning to be precipitated and discolored to a dark pink from the separation of the karanda fruits and kale without air bubbles.
	Treatment 3: sugar and xanthan gum The karanda fruits and kale juice mixed with sugar and xanthan gum have changed or precipitated to a light green color with few air bubbles. The karanda fruits and kale juice were not separated.	**Treatment 4: sucralose and xanthan gum** The karanda fruits and kale juice mixed with sucralose and xanthan gum are changed to a lighter color. The karanda fruits and kale juice were not separated.

Table 11: Sensory evaluation of 4 treatment of new healthy beverages keeping the shelf life for 7 days

Treatment	Attribute	Day1	Day2	Day3	Day4	Day5
1	Appearance	$6.90^b \pm 0.74$	$5.00^b \pm 0.67$	$4.70^b \pm 0.67$	$4.40^b \pm 0.52$	$4.20^c \pm 0.42$
	Color	$5.90^b \pm 0.74$	$5.10^b \pm 0.57$	$4.70^b \pm 0.67$	$4.60^b \pm 0.52$	$4.10^c \pm 0.32$
	Flavor	$5.40^b \pm 0.52$	$5.30^b \pm 0.67$	$5.00^b \pm 0.67$	$4.60^d \pm 0.52$	$4.40^d \pm 0.52$
	Sweetness	$5.50^c \pm 0.71$	$4.80^b \pm 0.79$	$5.00^b \pm 0.82$	$4.70^b \pm 0.48$	$4.50^c \pm 0.53$
	Sourness	$5.50^b \pm 0.92$	$5.50^b \pm 0.53$	$4.60^b \pm 0.70$	$4.60^b \pm 0.52$	$4.50^c \pm 0.53$
	Overall liking	$5.70^c \pm 0.48$	$5.30^c \pm 0.48$	$5.20^c \pm 0.63$	$4.80^d \pm 0.42$	$4.50^d \pm 0.53$
2	**Attribute**	**Day1**	**Day2**	**Day3**	**Day4**	**Day5**
	Appearance	$6.90^b \pm 0.74$	$5.10^b \pm 074$	$4.90^b \pm 0.88$	$4.60^b \pm 0.52$	$4.40^c \pm 0.52$
	Color	$5.60^b \pm 0.70$	$5.20^b \pm 0.63$	$4.90^b \pm 0.74$	$4.60^b \pm 0.52$	$4.50^c \pm 0.53$
	Flavor	$7.50^a \pm 0.53$	$7.30^a \pm 0.48$	$7.20^a \pm 0.42$	$6.80^b \pm 0.42$	$5.40^c \pm 0.52$

Table 11: Sensory evaluation of 4 treatment of new healthy beverages keeping the shelf life for 7 days (Cont.)

Treatment	Attribute	Day1	Day2	Day3	Day4	Day5
	Sweetness	7.40[b]±0.52	7.00[a]±1.05	7.00[a]±0.67	6.50[a]±0.53	5.30[b]±1.06
	Sourness	7.30[a]±0.48	7.10[a]±0.57	7.00[a]±0.47	6.60[a]±0.52	5.90[b]±0.57
	Overall liking	6.80[b]±0.42	6.50[b]±0.53	6.30[b]±0.48	5.90[c]±0.57	5.70[b]±0.48
3	**Attribute**	**Day1**	**Day2**	**Day3**	**Day4**	**Day5**
	Appearance	7.80[a]±0.63	7.60[a]±0.70	7.60[a]±0.70	7.20[a]±0.42	6.50[b]±0.53
	Color	7.40[a]±0.52	7.80[a]±0.79	7.80[a]±0.63	7.20[a]±0.42	6.50[b]±0.53
	Flavor	5.50[b]±0.53	5.40[b]±0.52	5.30[b]±0.67	5.70[c]±0.67	5.70[b]±0.48
	Sweetness	5.80[c]±1.55	4.90[b]±0.74	4.80[b]±0.79	4.70[b]±0.48	4.20[c]±0.79
	Sourness	5.90[b]±0.74	4.80[c]±0.63	4.80[b]±0.63	4.70[b]±0.48	4.50[c]±0.53
	Overall liking	7.00[b]±0.67	6.30[b]±0.67	6.30[b]±0.67	6.10[b]±0.57	5.00[c]±0.00
4	**Attribute**	**Day1**	**Day2**	**Day3**	**Day4**	**Day5**
	Appearance	7.90[a]±0.88	7.90[a]±0.74	7.70[a]±0.48	7.60[a]±0.52	7.00[a]±0.00
	Color	7.90[a]±0.88	7.80[a]±0.63	7.80[a]±0.42	7.30[a]±0.48	7.00[a]±0.00
	Flavor	7.80[a]±0.79	7.70[a]±0.67	7.60[a]±0.52	7.50[a]±0.53	6.80[a]±0.42
	Sweetness	8.50[a]±0.53	7.90[a]±0.74	7.60[a]±0.52	6.50[a]±0.53	6.40[a]±0.52
	Sourness	7.90[a]±0.74	7.90[a]±0.74	7.40[a]±0.52	6.50[a]±0.53	6.30[a]±0.48
	Overall liking	8.20[a]±0.63	7.90[a]±0.57	7.70[a]±0.48	6.80[a]±0.42	6.50[a]±0.53

[a-d] Means within the same row with different letters are significantly different ($P<0.05$).

From Table 11, the results of the five-day sampling of healthy beverages from karanda fruits and kale were found that the samples of products using sucralose and xanthan gum provided the highest appearance (7.00), color (7.00), flavor (6.80), sweetness (6.40), sourness (6.30), and overall liking (6.50) were higher than other samples. Xanthan gum is a polysaccharide that is mostly used in many industries such as a common food additive to thickening agent, emulsifier, and stabilizer. Adding xanthan gum to beverages can prevent ingredients from separating (Golly et al., 2019). Adding xanthan gum in beverages could prevent the separation of the new healthy beverages from karanda fruits and kale. Hence, treatments 3 and 4 (adding xanthan gum) had a higher appearance and color score than treatments 1 and 2 (no adding xanthan gum).

Conclusion

The development of new healthy beverages from karanda fruits and kale achieved all objectives of this study. The result showed that new healthy beverages from karanda fruits and kale have a basic formula consisting of the following components: the optimal ratio of kale and karanda fruits was 25:75 and using sucralose and xanthan gum in the formulation. The sensory evaluation with the ratio of 25:75 (kale and karanda fruits) had the highest overall liking (6.93+1.53). Hence, the selected basic formula was developed according to the formula by using the beverage products that received the highest ratings to adjust the formula to choose the best formula, all 4 formulas: formulation 1 sugar, formulation 2 sucralose, formulation 3 sugar with xanthan gum, formulation 4: sucralose with xanthan gum. From the experiment to develop healthy drink products karanda fruits and kale, the results found that formulation

with sucralose and xanthan gum was the best attribute sample and highest consumer liking score. The developed healthy drink from karanda fruits and kale received a moderate level of liking scores (7.11+0.30) and had a shelf-life of 4 days. 83% of consumers accepted the product and 92% of consumers were purchase intent.

Acknowledgments

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DEVELOPMENT OF SPAGHETTI WITH BANANA BLOSSOM CREAM SAUCE AND GINGER SPHERE

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Abstract

Banana blossom is considered a traditional food that has the potential to be regarded as a functional food due to its high galactagogues level associated with milk secretion. In order to develop a healthier choice ready-to-eat meal that enhances breast milk production of breastfeeding mothers after giving birth, the banana blossom of Namwa banana was used as the main ingredient to improve the spaghetti cream sauce recipe. This research aims to study the sensory preference and consumer acceptability of the developed spaghetti cream sauce recipe. The effect of flour types including "00" flour, all-purpose flour, and wheat flour on spaghetti qualities was evaluated by focus group interviews using 5 experts in the food business and the selected treatment was used as a basic spaghetti recipe. The effect of banana blossom processing methods including the submersion of the banana blossom in brine solution (2 %w/w), lime juice solution (0.2 %w/w), and citric acid solution (0.2 %w/w) on banana blossom appearance were also investigated by 5 experts in the food business and used as a standard processing method. After that, a sensory evaluation and consumer acceptance test of the ginger spaghetti with banana blossom cream sauce and ginger spheres was conducted with 100 target consumers.

The result revealed that the appearance and texture of spaghetti made from "00" flour had a uniformly smooth appearance and more al dente (tender and firm) when compared to the spaghetti made from all-purpose flour and wheat flour, respectively. In order to avoid the discolorations of the banana blossom after it was sliced, the submersion of the banana blossom in citric acid solution (0.2 %w/w) was the most effective method. According to the nutrient scores (22 out of 40), the developed spaghetti with banana blossom cream sauce and ginger sphere met the established criteria for acquiring the "Healthier Choice" logo. It has low calories (263.4 kcal/200 g), high protein, fiber, calcium, and iron while low in sodium and sugar. The sensory evaluation revealed that the majority of the panelists moderately on the appearance of the spaghetti (7.10 ± 1.37), the ginger flavor of the spaghetti (7.20 ± 1.12), the taste of the spaghetti (7.34 ± 1.23), the appearance of the banana blossom cream sauce (7.48 ± 1.27), taste of the spaghetti with banana blossom cream sauce (7.10 ± 1.32) and the overall liking (7.10 ± 1.29) of the spaghetti with banana blossom cream sauce and ginger sphere. However, 96% of consumers accepted this product and 80% of them decided to purchase the developed product at 50 THB per 200 g.

Keywords: Acceptability, Banana blossom, Ready-to-eat meal, and Spaghetti

Introduction

Thailand, the world's leading agricultural exporter, produces almost all types of fruit, mainly climacteric fruits like bananas (Musa spp.). From the past to the present, bananas are the fruit varieties that are grown mostly in Thailand, everywhere, all year round. Banana blossom, banana inflorescence, banana heart or Hua plea in the Thai langue is a large purple flower at the end of the banana bunch

which is a byproduct of banana cultivation. In a commercial situation, lots of banana blossoms are produced after the cultivation of bananas and are usually discarded as waste so it has a low cost. It is commonly consumed as food ingredients among Asians, particularly in India, Sri Lanka, Indonesia, Malaysia, and Thailand (Wickramarachchi & Ranamukhaarachchi, 2005). However, the banana blossom is a good source of dietary fiber (20.31 g/100g), protein (21.01g/100g), and natural antioxidants (Kanchana et al., 2005). It also has a tremendous nutritional value such as vitamins, minerals, flavonoids, and phytochemicals which help lower cholesterol and blood sugar level, anti-inflammatory, anticancer, and anti-aging (Ramu et al., 2017; Sarisa Thaweesang, 2019). Moreover, it has medicinal properties which suitable for women after childbirth or during breastfeeding since it contains lactagogum compounds which can help increase breast milk production (Aisya et.al., 2020; Nordin et.al., 2020). Diyan Wahyuningsih (2017) revealed that banana blossom could be used to be an alternative daily menu for postpartum mothers who have inadequate production of breast milk and low prolactin levels. Accordingly, the banana blossom has the potential to develop value-added milk booster products and the utilization of the banana blossom can reduce wastage and provide additional income to farmers.

Inadequate milk supply is a major difficulty encountered in breastfeeding. In order to overcome this problem, a mother needs to continue eating healthy and nutritious food. Traditionally, in Thailand, the banana blossom is a traditional lactation booster. To ensure adequate milk supply, Thai postpartum women normally cook and consumes food including banana blossom like Kaeng Liang (vegetable soup), Hua plea curry (curry with banana blossom), and Tom Kha Gai with banana blossom, and spicy banana salad with fresh shrimp. However, due to the evolution of women's work, women need to return to work outside the home after giving birth and they have no time to cook homemade meals. So, their behavior changes from home cooking to eating out or ready-to-eat meals,

The demand for ready-to-eat meals is growing rapidly due to their convenience, wide availability, appearance, taste, and shelf-stable. Since it can be brought anywhere and consumed anytime without any additional cooking, it is suitable for the busy lifestyles of women who are breastfeeding.

This study was, therefore, conducted to develop a healthier choice ready-to-eat meal from banana blossom as an alternative milk booster food for lactating working women that have energy between 250-500 kilocalories per serving and have a nutrition score compliance with the nutrient criteria of the healthier choice standard established by the Ministry of Public Health's Notification (2016) that could be offer benefits to the consumers such as convenience in preparation as well as promoting the intake of fiber among people. Spaghetti with carbonara sauce was chosen for this research since it is a popular and well-known ready-to-eat meal in convenience stores in Thailand and abroad. Both pastas and carbonara sauce contained banana blossom as an ingredient. The ginger juice topping was developed as appetite stimulation and to increase the nutritional value of lactating women.

Research Objectives

1. To develop the spaghetti with banana blossom cream sauce recipe and production processes.
2. To study the consumer acceptance on spaghetti with banana blossom cream sauce and ginger sphere.

Literature Review

1. Spaghetti alla Carbonara
Spaghetti Alla Carbonara is a traditional Italian dish. It is a combination of pasta and sauce. The carbonara sauce is made of raw egg yolks, black pepper, grated cheese, and Italian bacon (Lopes and Tondo, 2020). The sauce is heated using only the heat of cooked pasta. Due to the popularity of this dish, many variants of the sauce recipe were created based on the original recipe.

Spaghetti is a variety of long, thin, rounded pasta which is a collective name for Italian noodles. It is a category of foods made from flour and water, and often eggs and other ingredients. It is a rich source of complex carbohydrates. Generally, pasta contains approximately 80-85% carbohydrate 10-15% protein and 3-5% fat. It is produced by mixing milled wheat flour, water, and egg, then kneaded and cut into variant shapes (Fuad and Prabhasankar, 2010). There are two groups of pasta: fresh pasta and dried pasta. Fresh pasta has a slightly softer texture than dry pasta. Pasta quality is dependent on three main factors, the ingredients, the production recipe, and the production process (Dawe, 2001). High-quality pasta is normally made of durum wheat (*Triticum turgidum* L.), which provides a unique quality of pasta since it has relatively high yellow pigment content, low lipoxygenase activity, and high protein content (Aalami et al., 2007). However, it is possible to use non-durum wheat ingredients to produce specifically blended pasta. The three most commonly used types of flour for pasta-making are all-purpose flour, Semola flour, and "00" flour. Semola and 00 flour are both wheat flour, but they differ greatly in their texture and flavor. Semola flour is made of hard durum wheat with larger particles and a coarse texture, whereas "00" flour is a much finer powder.

Several ingredients can be added or replaced to improve the nutritional properties of pasta. For example, up to about 30% by weight of fiber can be added to reduce the calorie of pasta. High protein plant materials like soy isolates and pea protein are able incorporated in order to improve the nutritional properties of pasta.

2. Banana Blossom

Banana blossom, Banana flower, or Hua plea is the name of the banana inflorescence. It consists of real flowers that are encased in large red bracts. Characteristics are overlapping cladding until the end of the bouquet. Like a lotus bud When the female flowers grow as a result without being pollinated. Until it is a small combed banana, also known as "Banana Foot", the gardeners will cut the cabbage at the end of the bouquet. In order not to compete for food that will be fed to bananas. It also prevents the accumulation of pathogens in the banana chain. The cut bananas have a white texture. Crunchy, astringent taste. They go well with a wide variety of dishes in Thailand. Such as Pad Thai or Kanom Jeen Na Ya. It is popularly eaten as a chili dip with vegetables. In addition, it is also adapted to make various menus such as tom yum curry, steamed muffled, fried potato casserole, or deep-fried batter, giving it a delicious and nutritious taste similar to other vegetables. It also has the advantage of being organic vegetables. Because bananas are plants that do not require any chemicals to grow, the value that the body will get from eating 100 grams of banana blossom is 0.8 grams of dietary fiber, 28 mg of calcium, 40 mg of phosphorus, and 25 mg of vitamin C (Singh, 2017). Banana flowers contain many nutrients, including antioxidants, several minerals, and a small amount of protein. They're also low in calories and fat while offering a balance of insoluble and soluble fiber (Ramu, 2017). The ancients said it was Nourish the milk of the mother during breastfeeding. Treatment of freckles and heat in rubber from banana cabbage can be used to treat fresh wounds or paint areas where insect bites can also be found. In addition, Indian researchers have also found that banana blossom has properties to reduce blood sugar levels as well.

In Thailand, the very popular type of banana blossom is the banana blossom of Namwa banana because of the less astringent taste and easy-to-find. The banana blossom of *Musa* ABB cv. "Kluai Namwa" contained the highest total phenolic compounds (187.82±1.47 mgGAE/100g dry weight) when compare to *Musa* AA cv. "Kluai Khai" and *Musa* AAA "Kluai Hom" (Nuchsuk, 2018).

Banana blossom consumption of some traditional galactagogues was significantly correlated to human milk volume kinds of traditional galactagogues and proteins are associated with human milk volume. However, studies related to the active ingredients in these galactagogues are required to secure a recommendation about the use of traditional galactagogues among breastfeeding

mothers. (Buntuchai et al., 2017) n because it contains lactogogum (a kind of nutrient which can release the breastmilk) the result showed that after consuming bananas flower the breastmilk production is more than before (80%). the increasing breastmilk production in postpartum woman

3. Ginger

Ginger is a popular natural herb because it is rich in vitamins and minerals that are very important to our health such as vitamin A, vitamin B1, vitamin B 2 vitamin B3, vitamin C, beta-carotene, iron, calcium, phosphorus, and it also contains protein, carbohydrates, and fiber (Al-Awwadi, 2017). Moreover, for breastfeeding women, it can help to increase the breast milk volume in the early postpartum period without any notable side effects (Paritakul et al., 2016)

4. Spherification

Spherification is part of a food science trend called molecular gastronomy which involving in the application of the scientific technique to create an exotic burst-in-the-mouth effect from thin outer membrane spheres (semi-solid gel beads) with various encapsulated liquids inside using ions to trigger a gelling process. This solid, gel-like sphere can be made in various sizes, shapes as well as various firmness. Spherification requires two basic components, including sodium alginate and calcium. Sodium alginate is a hydrocolloid made from seaweed, while calcium is a type of salt. There are two versions of spherification techniques including basic spherification and reverse spherification.

For the basic spherification process, sodium alginate is dissolved in liquid food. Then the liquid is dropped into a container containing a solution of calcium lactate. Calcium is penetrated inside the liquid droplet and a gelling process starts from the outside skin, continuously. Once the sphere form, the sphere will completely gel through to the center over time. In the basic spherification process, the pH of the liquid is important. Low pH (below a pH of 3.6) alginate tends to convert into insoluble alginic acid, thickens the solution, and makes it difficult to form spheres droplets (Lee and Rogers, 2012).

Reverse spherification and frozen reverse spherification is a more complicated technique. It is commonly used with calcium-containing liquids such as milk or with high acidity liquid (below a pH of 3.6). The calcium lactate is dissolved in liquid food. Then the liquid is dropped into a container with sodium alginate solution. Unlike the direct version, the formation of a gel then occurs only around the outer skin liquid droplet (Bubin et al., 2019).

5. Healthier Choice

Globally, people of all age groups are affected by non-communicable diseases (NCDs) such as diabetes, heart attack, high blood pressure, coronary heart diseases, stroke, cancer, and chronic lung disease. NCDs are the key causes of death for people with unhealthy consumption behaviors, such as overconsumption of food with excessive contents of sugar, sodium, and/or fat which are the fundamental factors that cause the NCDs. For the prevention of overconsumption, nutrition facts labeling on food packages assist consumers to know how much nutrients they are receiving from a particular food product. The National Food Committee and the networks have realized this problem and are trying to raise public awareness through the use of simplified nutrition labeling or so-called "Healthier Choice" nutritional logo.

The "Healthier Choice" criteria used for each food category are established according to the technical guidance of the sub-committee on the development and promotion of simplified nutrition labeling. The ready-to-eat meal is one of the food products including the food categories that are eligible for applying the "Healthier Choice" nutritional logo. A ready-to-eat meal in both frozen and chilled forms usually provides 250-500 kcal per serving. It contains complete nutrients especially calories, carbohydrates, protein, and fat that potentially increase the risk of NCDs. Qualified food products in this category must meet the following criteria for acquiring the "Healthier Choice" nutritional logo:

1. Having energy between 250-500 kilocalories per serving
2. Fat, saturated fat, sugar, and sodium score must be higher than 0
3. Total scores of nutrients per 100 kcal must be 20 or more out of 40

Methodology

1. Development of Spaghetti with Banana Blossom Cream Sauce and Ginger Spheres

1.1 The Study on the Effect of Flour on Spaghetti Quality

Basic spaghetti recipes were prepared with 4 main ingredients; flour, eggs, olive oil, and salt. In this study, the effect of three different types of flour including "00" flour, all-purpose flour, and wheat flour was compared in each spaghetti recipes A, B, and C, respectively. The other list of ingredients in the recipe was the same but different in a ratio according to **Table 1.**

Table 1: Ingredients of three spaghetti recipes per 100 grams

Ingredients	Recipes (%)		
	A	B	C
"00" flour	62.0	-	-
All-purpose flour	-	50.7	-
Wheat flour	-	-	52.6
Whole egg	37.4	45.7	42.3
Olive oil	0.5	3.5	5.0
Salt	0.1	0.1	0.1
Total	**100**	**100**	**100**

All ingredients were mixed with the mixer. The dough was kneaded for 10 minutes until it become cohesive and smooth. After that, it was shaped into a ball and wrapped in plastic wrap. The dough was rested at room temperature for 30 minutes. Then it was gently flattened into oval pasta sheets with a rolling pin and was rolled through the level 4 setting of the pasta maker with a kitchen aid attachment. The pasta sheets were folded in half and repeated the rolling process 3 times. The pasta sheets were then sprinkled with flour and cut through the pasta cutter into a long strip of 1-millimeter thick spaghetti. The spaghetti was cooked in the boiled ginger juice (50% w/w) for 12 min before being served.

Three basic spaghetti recipes were compared and selected by 5 experts in the food business for further development according to the spaghetti's appearance and texture.

1.2 The Study on Banana Blossom Processing Methods

Banana blossoms of Musa ABB cv. "Kluai Namwa" variety with firm, tightly packed bracts and no signs of decay were brought from supermarket market in Nonthaburi, Thailand. The samples were washed thoroughly in running water. The tough purplish outer layers' bracts were removed and discarded until the tender pale pink blossoms with yellow-tipped will appeared. The purplish bracts were removed and discarded until the color became white or pale. At this point, pale-colored bracts were horizontally chopped off into two-part. The conical stem was trimmed and discarded.

In order to avoid the discolorations and bitterness of the banana blossom after it was sliced, three different processing methods including the submersion of the banana blossom in brine solution (2%w/w), lime juice solution (0.2 %w/w) and citric acid solution (0.2 %w/w) were determined (Jha et.al.,2021; Elaveniya and Jayamuthunagai, 2014). The 100 g of sliced banana blossom was soaked

in 1000 ml of solution for 30 min and blanched in hot water (at 96-98 oC for 5 min). Then it was rinsed in cold water and drained out excess water. The appearance, color, texture, taste, and flavor of sliced banana blossoms were evaluated by 5 experts in the food business.

1.3 Development of Banana Blossom Cream Sauce

Three basic cream sauce recipes were compared and selected by 5 experts in the food business. The ingredients of the cream sauce were listed in **Table 2**. The sauce recipe was prepared by using sliced banana blossom pre-treated with the citric acid solution (0.2% w/w) for 30 min and blanched at 96-98 °C for 3 minutes as a substitute for bacon (100%). Firstly, the sliced banana blossom was simmered in a pan over medium heat for 2 minutes until evenly cooked and turned off the heat. Then, mixed the eggs, grated parmesan cheese, and black pepper in the bowl. After that, whisk the mixture until it was creamy, and added the sliced banana blossom to the sauce. The best recipe was selected according to its taste, nutrition, and energy.

Table 2: The ingredients of banana blossom cream sauce per 100 grams

Ingredients	Recipes (g)		
	A	B	C
Bacon	24.0	21.3	16.5
Milk	49.0	-	-
Whole egg	16.0	13.9	-
Egg yolk	-	-	19.3
Grated parmesan cheese	3.0	12.8	1.1
Salt	-	-	0.3
Black pepper	1.0	0.9	-
Olive oil	4.0	3.2	-
Garlic	3.0	2.1	-
Onion	-	21.3	-
Butter	-	3.2	-
Whipped cream	-	21.3	62.8
Total	**100.0**	**100.0**	**100.0**

1.4 Ginger Juice Spherification

According to the procedure adopted by Lee and Rogers (2012), ginger juice spheres were conducted by dissolving food-grade sodium alginate (1% w/w) (Chemipan corporation co. ltd, Thailand) in 100% ginger juice extract (1% w/w) and blended by using the blender for 2 min. The ginger solution was cooled at 4 °C for 3 h before being dropped into the calcium lactate solution (1 % w/w) bath in a drop-by-drop manner, using a syringe. The ginger juice spheres were exposed to calcium lactate solution at room temperature for 2 minutes and then rinsed with distilled water.

2. Consumer Acceptance Test of the developed Ginger Spaghetti with Banana Blossom Cream Sauce

A sensory evaluation and consumer acceptance test of the spaghetti with banana blossom cream sauce and the ginger sphere was conducted with 100 target consumers. The selected consumers were asked to evaluate the developed recipe in terms of the following parameters; the appearance of the spaghetti, the ginger flavor of the spaghetti, the overall taste of the spaghetti, the appearance of the banana blossom cream sauce, and the overall liking of the spaghetti with banana blossom cream sauce and ginger sphere, using the 9-point hedonic scale (1 = "dislike extremely," 9= "like extremely"). The

experimental data were expressed as mean ± standard deviations. For the consumer acceptance test, the consumers were asked for their acceptance and purchasing intention of the developed recipe. The data were expressed as percentages.

Results and Discussion

1. Development of Spaghetti with Banana Blossom Cream Sauce and Ginger Spheres
    1.1. Effect of Flour on Spaghetti Quality

Effects of the "00" flour, all-purpose flour, and wheat flour on spaghetti quality were discussed and compared by 5 experts in the food business using focus group method. The best recipe was selected according to the dough quality, the spaghetti appearance, and its texture. In terms of the dough quality, recipe A which was made from "00" flour had a soft firm dough that could easily be cut with the cutter machine into a long strip shape while recipe B's dough which was made from all-purpose flour was too dry and tough, and recipes C's dough which made from wheat flour was too sticky.

The appearance and texture of spaghetti recipe A after cooking had a uniformly smooth appearance and more al dente (tender and firm) when compared to recipes B and C. The spaghetti recipe B had a too mushy texture and was broken into two or more fragments after cooking while the spaghetti recipe C had a tough and sticky texture with rough skin. Accordingly, with repetition, 5 out of 5 experts agree that spaghetti recipe A was better than recipes B and C.

The quality of spaghetti in this study could be explained by the protein content of gluten in the flour composition and the particle size of the flour. The amount of gluten in the flour is responsible for the firmness and the al dente feeling of the pasta (Sissons et al., 2008). If the gluten network in pasta was too weak the pasta will become mushy and if it was too strong the pasta will become too fragile. Wheat flour had the highest gluten content (12-14%) followed by all-purpose flour (9-12%) while the "00" flour has the lowest gluten than all-purpose flour and wheat flour so it made the dough quality softer and easier to shape. Moreover, wheat flour has larger particles and a coarse texture than all-purpose flour and the "00" flour so the spaghetti made of "00" flour had uniformly smooth skin than others (Samaan et al., 2006). Accordingly, spaghetti recipe A which is made from the "00" flour was chosen for the developed recipe.

1.2. Banana Blossom Processing Methods

In order to avoid the discolorations and bitterness of the banana blossom after it was sliced, the results of the study indicated that the submersion of the banana blossom in citric acid solution (0.2 %w/w) was effectively minimized the occurrence of browning color and bitterness of the banana blossom. It had a relatively lower color change when compared to the submersion of the banana blossom in brine solution and lime juice solution at 0.2 %w/w. Cut-surface browning of sliced banana blossom caused by the action of polyphenol oxidase (PPO) released during the process of cutting (enzymatic browning). Citric acid can retard browning by lowering the pH of the banana blossom to minimize the activity of PPO (Suttirak and Manurakchinakorn, 2010). The results in this study were similar to Kanchana et al. (2005) who have found that 0.2% w/w citric acid significantly reduced the browning in sliced banana blossoms. Accordingly, citric acid was selected as the pre-treatment for banana blossom processing methods.

1.3. Development of Banana Blossom Cream Sauce

The nutrition values of the banana blossom cream sauce recipes before and after substituting the bacon with banana blossom were listed in **Table 3.**

Table 3: Nutrition values of the banana blossom cream sauce recipes before and after substituting the bacon with banana blossom

Nutrients	A		B		C	
	Before	After	Before	After	Before	After
Total Fat **g**	17.0	7.0	24.7	16	31.8	24.7
Saturated Fat **g**	5.4	2.1	11.2	8.3	16.5	14.1
Cholesterol **mg**	92.0	66.0	114.0	91.0	324.0	305.0
Sodium **mg**	619.0	111.0	651.0	216.0	820.0	467.0
Total Carbohydrate **g**	4.6	5.1	4.8	5.2	2.8	3.2
Dietary Fiber **g**	0.3	0.9	0.8	1.3	0	0.4
Total Sugars **g**	1.0	1.0	0.9	0.9	0.2	0.2
Protein **g**	13.8	5.2	14.7	7.2	11	4.9
Calcium **mg**	106.0	115.0	154.0	161.0	79.0	85.0
Iron **mg**	1.0	1.0	1.0	1.0	1.0	1.0
Calories **kcal.**	226	102	296	188	339	251

The substitution of banana blossom could reduce approximately half the calories of bacon cream sauce. Moreover, it reduced total fat, saturated fat, cholesterol, and sodium with helped the recipe healthier. However, the protein was also largely decreased. The recipe which has the lowest calories was recipe A, followed by recipes B and C, respectively. The taste of recipe A was accepted by the expert. Accordingly, the recipe A banana blossom cream sauce was selected for the spaghetti with banana blossom cream sauce and ginger spheres dish.

    1.4   Development of Spaghetti with Banana Blossom Cream Sauce and Ginger Spheres

In order to develop the healthier choice of spaghetti with banana blossom cream sauce and ginger spheres, the dish composed of three compositions including the spaghetti, the banana blossom cream sauce, and ginger spheres was calculated for the nutrient score. The 100 g of boiled spaghetti was prepared by using the spaghetti recipes A (62.0% "00" of flour, 37.2% of eggs, 0.5% of olive oil, and 0.2% of salt). It was cooked in the boiled ginger juice (50% w/w) for 12 min before being drained, mixed with 100 g of banana blossom cream sauce (24% of banana blossom, 49% of milk, 16% of eggs, 3% of parmesan cheese, 1% of black pepper, 4% of olive oil and 3% of garlic) and sprinkled with the ginger spheres. The nutrient scores of the developed ginger spaghetti with banana blossom cream sauce were shown in **Table 4**.

Table 4: The nutrient Scores of the developed Ginger Spaghetti with Banana Blossom Cream Sauce

Type of nutrient	Unit	Amount per one serving	Score
Protein	g	12.8	5
Calcium	mg	127.0	5
Iron	mg	1.6	5
Fiber	g	5.2	5
Total Fat	g	10.1	0
Saturated Fat	g	2.9	0
Total Sugar	g	1.18	1
Sodium	mg	167.4	1
Scores of nutrients per 100 kcal			22

According to the nutrient criteria of the "Healthier Choice" nutritional logo in compliance with the Ministry of Public Health's Notification No.373 (2016), the developed spaghetti with banana blossom cream sauce and ginger sphere met the established criteria for acquiring the "Healthier Choice" logo as following:

1. It had 263.4 kcal of energy which met the criteria of energy between 250-500 kcal per serving

2. Total score of total fat, saturated fat, sugar, and sodium score was 2 which is higher than 0

3. Total score of nutrients per 100 kcal was 22 out of 40

Therefore, the developed spaghetti with banana blossom cream sauce and ginger sphere was the recommended choice of food that had a better nutrient profile than the food product in the same category and may contribute to a reduced risk of NCDs caused by the consumption of such food.
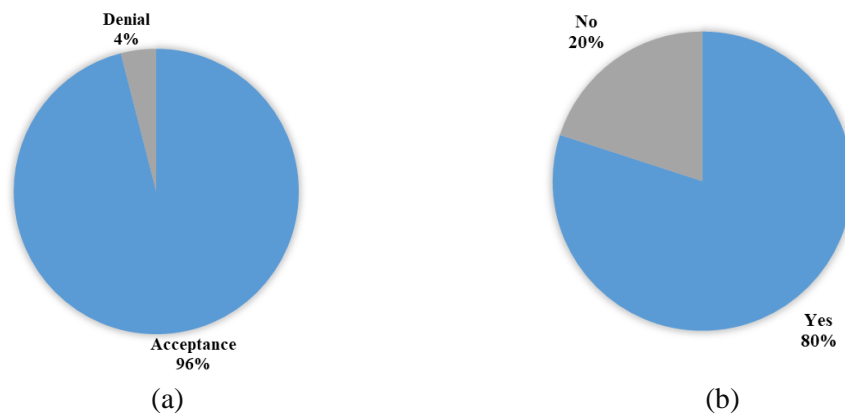
4. Consumer Acceptance Test of the developed Ginger Spaghetti with Banana Blossom Cream Sauce

The sensory evaluation of the developed spaghetti with banana blossom cream sauce and ginger sphere by the 100 untrained panelists on sensory attributes is represented in **Table 5.** The table showed that the majority of the panelists liked moderately the appearance of the spaghetti, ginger flavor of the spaghetti, taste of the spaghetti, the appearance of the banana blossom cream sauce, taste of the spaghetti with banana blossom cream sauce, and the overall liking of the spaghetti with banana blossom cream sauce and ginger sphere.

Table 5: Sensory attributes of the developed Ginger Spaghetti with Banana Blossom Cream Sauce

Attributes	Sensory score (mean ± standard deviations)
The appearance of the spaghetti	7.10 ± 1.37
Ginger flavor of the spaghetti with ginger sphere	7.20 ± 1.12
Taste of the spaghetti	7.34 ± 1.23
The appearance of the banana blossom cream sauce	7.48 ± 1.27
Taste the spaghetti with banana blossom cream sauce	7.10 ± 1.32
Overall liking	7.10 ± 1.29

For the consumer acceptance test, the majority of panelists (96%) accepted this product. About four percent denied this product because of the ginger flavor. The majority of panelists (80%) decided to purchase the developed product at 50 THB per 200 g because it had good nutritional value, tasty and flavorful (Picture 1). Twenty percent of panelists considered not purchasing this product because of the ginger flavor.

Picture 1: The acceptance (a) and the buying decision
(b) of the developed spaghetti with banana blossom cream sauce and ginger sphere

Conclusions

In conclusion, the developed spaghetti with banana blossom cream sauce and ginger sphere recipes (200g per container) contained 100 g of boiled spaghetti (62.0% "00" of flour, 37.2% of eggs, 0.5% of olive oil, and 0.2% of salt) and 100 g of banana blossom cream sauce (24% of banana blossom, 49% of milk, 16% of eggs, 3% of parmesan cheese, 1% of black pepper, 4% of olive oil and 3% of garlic) and sprinkled with the ginger spheres met the established criteria for acquiring the "Healthier Choice" logo. It has low calories (263.4 kcal/200 g), high protein, fiber, calcium, and iron while low in sodium and sugar. The sensory evaluation revealed that the majority of the panelists moderately on the appearance of the spaghetti (7.10 ± 1.37), the ginger flavor of the spaghetti (7.20 ± 1.12), the taste of the spaghetti (7.34 ± 1.23), the appearance of the banana blossom cream sauce (7.48 ± 1.27), taste of the spaghetti with banana blossom cream sauce (7.10 ± 1.32) and the overall liking (7.10 ± 1.29) of the spaghetti with banana blossom cream sauce and ginger sphere. However, 96% of consumers accepted this product and 80% of them decided to purchase the developed spaghetti with banana blossom cream sauce and ginger sphere recipes at 50 THB per 200 g.

Acknowledgments

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MARKETING MIX FACTORS AFFECTING THE CONSUMER DECISION TO BUY STREET FOOD DURING THE COVID-19 PANDEMIC IN NONTHABURI PROVINCE

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Abstract

The purpose of this research is to study the marketing mix factors affecting the consumer decision to buy street food during the COVID-19 pandemic in the Nonthaburi province. The sample group is consumers who bought street food during the COVID-19 pandemic in the Nonthaburi province. The samples were 400 people aged 20 years and over, analyzed by using descriptive statistics such as frequency, percentage, mean, and the statistical inference using the multiple regression analysis.

The result found that the most respondents were female (64.8%) and male (35.3%), aged between 21-30 years old (35.8%), single status (83.5%), and highest education were bachelor's degree (55%), the occupation was a student (45%), and have income per month under 15,000 baths (32.8%). The consumer behavior of buying street food, most respondents bought a la carte (19.5%). The frequency of buying street food was 4-5 days per week (52.5%), were spent between 151-200 baths per week (61.8%), and were purchased between 10:00 am. – 3.00 pm. (56.0%), had a problem of paying by cash only (44.7%). Most respondents' decision to buy street food during the covid-19 pandemic in Nonthaburi province was because of their trust and confidence in the street food vendors' practice followed by COVID-19 control measures ($\bar{x}$= 4.29, S.D.= 0.716), followed by their can ordering from the online delivery platform ($\bar{x}$= 4.27, S.D.= 0.745) and the location with easy access, close to home and office ($\bar{x}$= 4.15, S.D.= 0.454) respectively. The result of the hypothesis found that place, promotion, people, process, and physical evident factors affecting the consumer decision to buy street food during the covid-19 pandemic in Nonthaburi province, accepted with statistical significance at the 0.05 level. The marketing mix factors can predict 69.6 percent of consumer decisions. Therefore, the consumer decision using multiple regression model was 0.370 (constant) + 0.172 (place) -0.126 (promotion) + 0.434 (people) + 0.269 (process) + 0.133 (physical evident)

Keywords: Marketing Mix 7Ps, Street Food, COVID-19

Introduction

The situation of the coronavirus epidemic (COVID-19) has affected consumers' lifestyles such as socializing, buying behavior, especially food and drink. Foodservice business is one of the businesses that had been affected since the pandemic, lockdown, and reopening. To give a consumer trust and confidence, the food operators have to provide a quality of food and service that focus on customer safety as a priority. However, The Ministry of Public Health (MDOH) has practiced in compliance with COVID-19 control measures for food service businesses in three groups the food service owners, food

service workers, and consumers. (Ministry of Public Health, 2021) Street food is ready-to-eat foods and beverages prepared, sold in the street, and served by vendors in public places. (Food intelligent center, 2017) Therefore, street food vendors need to follow the MDOH policy in order to prepare and open the country, welcome the visitor, and make all consumers trust and confident when buying the street food from street food vendors. The importance of the marketing mix factors; product, price, place, promotion, people, process, process, and physical evidence need to improve on the need of consumers, understand consumers and apply to the operation. The result of the study can help a street vendor knows the need of the consumer, and the decision to buy and can apply to the street food service and build trust by offering products and services that match consumer expectation in their safety.

Research Objective

To study the marketing mix factors (7P's) that affect the consumer decision to buy food from street food in the situation of the COVID-19 pandemic

Literature Review

Marketing Mix

The service business is different from the consumer goods business because the service business is a tangible business and intangible, Therefore, the marketing strategies applied to service businesses are different from those in general marketing. Kotler & Keller (2006) defines the marketing mix as a marketing mix for a service business, it means a business that provides services that are different from consumer goods and general consumer goods. It is necessary to use 7 Marketing Mix or 7P's in formulating a strategy for a business. services to be used in the management of the store by giving importance to each aspect respectively as follows

1. Products are what the seller has to give to the customer .Must respond to customer needs, and customers must be a benefit and value from that product. In this study are hygienically clean food, the taste of food, varied menu, food containers, and utensils are packed in the packet**.**

2. Pricing is a consumer decision zone of ability to pay. This study clearly displays price, quality, and quantity worth the price, price has not often changed.

3. Place is a suitable place where they can purchase street food foods. This study is easy to access; close to home or office, have many branches, and can order delivery via platform online.

4. Promotion is informed various promotions that persuade buyers to be interested in the street food foods; promotion and discounts from vendors, vendors have a promotion on the delivery platform, and offering a set menu**.**

5. People is a food seller which able to create customer satisfaction and build a good relationship with customers; sellers have good interaction with customers, sellers wear mask, gloves, and apron, sellers have good personal hygiene, and has pin showing the sellers vaccinated.

6. Process is an activity that deals with process and operation in customer service. In this study food ordering is not difficult, taking a short time to receive food, fast service, get the right orders, and having payment option.

7. Physical evidence is an overall street food vendor atmosphere that gives customers an impression; that the place and overall are clean, having gel alcohol sanitizing, sensor measures the temperature, and SHA/SHA+ remarks in stores.

Street food

Street food is food that is sold on the street, sold by hawkers, stalls, and carts, street food is essential to the lives of urban and low-income residents. It allows both groups of individuals to continue their lives. Another meaning of street food is food that can be consumed immediately and there is food

on the roadside, next to the park, the train station, customers can order items as needed, which the merchants have prepared and cooked immediately. Customers can sit and eat at the restaurant or take it home. The cost per visit is lower than eating in a restaurant. Types of street food are divided into two main types. First is savory food such as rice topped with curry, rice bag, papaya salad, northeastern food, noodles, a la carte food, one dish good such as grilled, fried, etc. Second is sweet food such as various kinds of snacks, ice cream, dessert, as well as fruits and beverages, etc.

During the COVID-19 pandemic, street food has been greatly affected by the return of customers due to the food hygiene standards. Customer is more concerned about food safety. The street food business is at high risk from the economic environment and even more on the pandemic of the COVID-19 virus. At the present street food can be back to open as usual but the number of customers and revenue is less still. As a result of the increase in the number of streets food characteristics are similar and also has no variety of payments. Plus a large number of chain restaurant operators have added a variety of food brands and expanded branches to all areas this is causing more intense competition among consumers using convenience food stores and more at shopping centers. The usage of street food is a trend high risk also will continue to decline.

From the above statement, it can be concluded that problems with using street food services arise from many factors such as risks from economic conditions, causing consumer behavior to change according to the pandemic situation. If street food does not have an adaptation strategy to match the current situation this may cause the operator to lose income or may have to shut down the business.

Hypothesis

H_1 Product factors affecting the consumer decision to buy street food during the COVID-19 pandemic in Nonthaburi province.

H_2 Price factors affecting the consumer decision to buy street food during the COVID-19 pandemic in Nonthaburi province.

H_3 Place factors affecting the consumer decision to buy street food during the COVID-19 pandemic in Nonthaburi province.

H_4 Promotion factors affecting the consumer decision to buy street food during the COVID-19 pandemic in Nonthaburi province.

H_5 People factors affecting the consumer decision to buy street food during the COVID-19 pandemic in Nonthaburi province.

H_6 Process factors affecting the consumer decision to buy street food during the COVID-19 pandemic in Nonthaburi province.
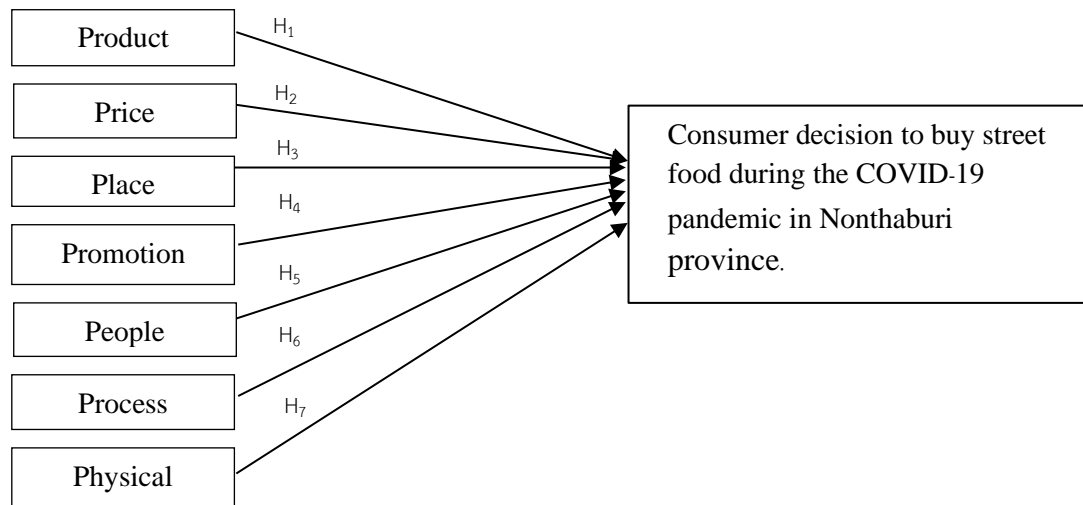
H_7 Physical evidence factors affecting the consumer decision to buy street food during the COVID-19 pandemic in Nonthaburi province.

Conceptual framework

Picture 1: Conceptual framework

Methodology

This study is the quantitative research methodology with purposive sampling applied in this study and used a questionnaire to collect data that tested a validity from 3 experts and the Item-Objective Congruence (IOC) is 0.84. The tool was tested by a similar population of 30 people for testing reliability with Cronbach's Alpha Coefficient is 0.84 which is more than 0.70. Hence, this questionnaire was considered reliable. The data were analyzed by percentage, mean and standard deviation, and multiple regression.

The population in this study is consumers who used to buy street food after government announce to reopening, age over 20 years old lives in Nonthaburi province, which does not know the amount of population.

The sample size was calculated by Cochran's formula to determine the confidence level of 95% with an error of 5. (Cochran, 1977). The total sample size is 385 samples. In this study, we add 4% to the sample. Thus, the total sample size in this study is 400 samples.

Results and Discussion

Most respondents were female (64.8%) and male (35.3%), aged between 21-30 years old (35.8%), single status (83.5%), highest education was bachelor's degree (55%), the occupation was a student (45%), and have income per month under 15,000 baths (32.8%).

The consumer behavior of buying street food, most respondents bought a la carte (19.5%). The frequency of buying street food was 4-5 days per week (52.5%), were spent between 151-200 baths per week (61.8%), and were purchased between 10:00 am. – 15.00 pm. (56.0%), had a problem of paying by cash only (44.7%)

Table 1: Means and standard deviation of the marketing mix of consumer decision to buy street food during the COVID-19 pandemic in Nonthaburi province

Marketing Mix	Level of Important		
	$\bar{x}$	S.D.	Interpret
Product	4.41	0.575	Strongly agree
Price	4.30	0.419	Strongly agree
Place	4.28	0.453	Strongly agree
Promotion	4.28	0.728	Strongly agree
People	4.29	0.521	Strongly agree
Process	4.33	0.407	Strongly agree
Physical Evidence	4.10	0.649	agree
Total	4.28	0.536	Strongly agree

From Table 1, it shows that the factor that affected the decision to buy street food during the covid-19 pandemic in Nonthaburi province was the product ($\bar{x}$=4.41, S.D.=0.575), followed by process ($\bar{x}$=4.33, S.D.=0.407 and price ($\bar{x}$=4.30, S.D.=0.419, respectively.

Table 2: Means and standard deviation of consumer decision to buy street food during the COVID-19 pandemic in Nonthaburi province

Deciding Factor	Level of Selecting Decision		
	$\bar{x}$	S.D.	Interpret
Ordering from online delivery platform	4.27	0.745	Strongly agree
Trust and confidence in the street food vendors' practice followed by Covid-19 control measures	4.29	0.716	Strongly agree
The location with easy access, close to home and office	4.15	0.454	Agree
Total	**4.24**	**0.638**	Strongly agree

From Table 2, it shows that the most respondents decision to buy street food during the COVID-19 pandemic in Nonthaburi province because their trust and confidence the street food vendors practice followed by COVID-19 control measures ($\bar{x}$= 4.29, S.D.= 0.716), followed by their can ordering from online delivery platform ($\bar{x}$= 4.27, S.D.= 0.745) and the location with easy access, close to home and office ($\bar{x}$= 4.15, S.D.= 0.454)

Table 3: Result of multiple regression analysis of the marketing mix of customer decision to buy street food during the COVID-19 pandemic in Nonthaburi province

Marketing mix factor	b	SE. b	β	t	Sig.
(Constant)	0.370	0.157		2.351	0.019*
Product	0.011	0.027	0.013	0.393	0.695
Price	0.013	0.048	0.011	0.270	0.787
Place	0.172	0.046	0.163	3.708	0.000*
Promotion	-0.126	0.022	0-.193	-5.763	0.000*
People	0.434	0.042	0.474	10.266	0.000*

Table 3: Result of multiple regression analysis of the marketing mix of customer decision to buy street food during the COVID-19 pandemic in Nonthaburi province (Cont.)

Marketing mix factor	b	SE. b	β	t	Sig.
Process	0.269	0.054	0.229	4.935	0.000*
Physical Evident	0.133	0.027	0.181	4.983	0.000*
R=0.837		R Square = 0.701		Adjusted R Square = 0.696	
Std. Error of the Estimate = 0.263		F = 207.874		P = 0.000*	

*Significant level at 0.05

The predicting of consumer decision on customer decision to buy street food during the COVID-19 pandemic in Nonthaburi province was 69.6% (adjusted r square), and the standard error is 0.263. The relationship between the marketing mix factors and customer decision on buying street food during the COVID-19 pandemic in Nonthaburi province. Thus, the result of the marketing mix factors and consumer decisions could be written in the form of the Equation Model as follows:

Consumer decision = 0.370 (constant) + 0.172 (place) -0.126 (promotion) + 0.434 (people) + 0.269 (process) + 0.133 (physical evident)

The result of the hypothesis found that place, promotion, people, process, and physical evident factors affected the consumer decision to buy street food during the COVID-19 pandemic in Nonthaburi province

Conclusion

The result of marketing factors of consumer decision to buy street food during the COVID-19 pandemic in Nonthaburi province. In general, the level of agreement was strongly agree ($\bar{x}$=4.28, S.D.=0.536) most respondents strongly agreed, with the first product factor ($\bar{x}$=4.41, S.D.=0.575). The components in food service such as plastic utensils for takeaway or eating need to cover or seal with an individual package, to maintain food quality, especially when customers order for takeaway and have a varied menu Secondly Process factor ($\bar{x}$=4.33, S.D.=0.407), the process in service must be quick and correct, has an option to pay by banking transfer which avoids touching cash. Thirdly price factor price ($\bar{x}$=4.30, S.D.=0.419), the street vendors must have a consistency of price, clearly display price, the quality, and quantity worth the price that customer pay. Next place factor ($\bar{x}$=4.29, S.D.=0.521) and promotion factor ($\bar{x}$=4.28, S.D.=0.728) which are easy access, consumers make a decision because the customer can order delivery via platform online. The street vendors are close to their home or their office and some vendors have more than one branch. However, the promotion factor consumer attend s to the promotion on the delivery online platform, having promotion and discounts from vendors, and offering a set menu. Finally, the physical evidence factor ($\bar{x}$=4.10, S.D.= 0.728), the consumer decision to buy from the street vendors which represented an SHA or SHA+, providing gel alcohol and temperature sensor and the cleanliness of the service area.

To enable the results of this study to be expanded in a broader perspective the researcher would like to suggest for the next research. Conducting a population/sample study in other areas which will have a variety of consumer behavior resulting in receiving new educational results and should conduct a qualitative research in order to gain in-depth information on that study.

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SENSORY EVALUATION OF CRAFT CHOCOLATE BAR PRODUCE FROM 4 COCOA PLANTATIONS IN THAILAND

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Abstract

The number of cocoa farms is gradually increasing in Thailand. Since the processing of craft chocolate bars is influenced by cocoa beans used, there are currently a variety of single origins of cocoa beans from each region of Thailand. According to a simple processing process of chocolate, including fermenting, drying, roasting, and coaching, there are many local craft chocolate products introducing into chocolate markets in Thailand. Significantly, the differences in taste, flavor, and aroma of Thai craft chocolate bring the uniqueness of local craft chocolate. This study aims to sensory evaluation of craft chocolate bars produced from 4 plantations in Thailand. The materials used in this study were single-origin craft chocolate bars from 4 different plantations, which are from Chiang Mai, Chantaburi, Prachaup Khirikahn, and Chumphon Province. The craft chocolate bars were sensory evaluated including aroma, acidity, bitterness, astringency, defects, flavor, and aftertaste. The results showed that there was no significant difference in the intensity of each attribute, and the quality of each attribute was shown similar results. In terms of the final scores of the sensory analysis, they were not significantly different, the score belonged to Chumphon, Chiang Mai, Chantaburi, and Prachaup Khirikahn Province, respectively.

Keywords: Sensory Evaluation, Craft Chocolate, Plantation, Thai Cocoa

Introduction

During 2019-to 2022, the number of cocoa farms was increasing among Thai farmers. Cocoa farming was introduced to many farmers all over Thailand since cocoa trees were able to grow in the mixed crops. Significantly, Thailand is in the perfect location nearby the equator line for growing tropical fruits especially cacao trees and so on (Damecacao, 2020). According to the Department of Agriculture Extension (2020), the area of cocoa farms in Thailand was estimated about at 2,300 acres (5,913 Rai), which there are 30% in the south, 29% in the north-east, 23% in the north, 9% in the west, 5% in the central and 4% in the east. And Ancreasing numbers of Thai farmers are interested in cocoa farming so there are a lot of cocoa pods introduced to the chocolate market in Thailand. And according to the Customs Department, the domestic cocoa production in 2020 was estimated at about 859 tons of dried cocoa beans. From this scenario, the supply chain of cocoa in Thailand becomes more productive. Currently, craft chocolate from Thai cocoa was increasing introduced to the chocolate market in Thailand. There are many choices of Thai craft chocolate products originally from all over the country. In addition, local consumers have known Thai craft chocolate as either tree tree-to-barbean to bar chocolate. Nowadays, there is an increasing number of craft chocolate stores in Thailand mainly in the Bangkok area and other big cities such as Chiang Mai, Nakhonsrithammarat, and so on. Recently, Thai craft chocolate brands, PARADAi, Matchima, SIAMAYA, and Kanvela, were awarded 2021 the Academy of Chocolate Award (AOC) and the International Chocolate Awards (ICA).

Current information on the **w**orld's **Cocoa D**emand and **s**upply

According to the International Cocoa Organization in 2020, the world's cocoa production was estimated at about 4.6 million tons, which most of the world's cocoa production locates in a narrow belt between either ten degrees north or south of the equator. Significantly, the cocoa production of the Ivory Coast was estimated at about 45%, 17% of Ghana, 7% of Ecuador, 5% of Indonesia, 5% of Nigeria, and 21% of the rest of the world. However, the cocoa production in Thailand in 2020, there is only 0.02% of the world's cocoa production.

Table 1: Table of World's cocoa production in 2020

No.	Country/Location	Production (%)
1	Ivory Coast	45
2	Ghana	17
3	Ecuador	7
4	Indonesia	5
5	Nigera	5
6	Rest of the world	21
*	Thailand	0.02

Source: International Cocoa Organization (ICCO), 2020

In addition, the International Cocoa Organization 2020 stated that the value of cocoa import was estimated at 5.1 million USD. Significantly, the cocoa import value of Germany was estimated at about 10%, 10% of the United States of America, 9% of the Netherlands, 7% of France, 5% of the United Kingdom, and 59% of the rest of the world. However, for the cocoa import value in Thailand in 2020, there is about of % of the world's cocoa imports.

Table 2: Table of World's cocoa imports in 2020

No.	Country/Location	Import Value (%)
1	Germany	10
2	United States of America	10
3	the Netherlands	9
4	France	7
5	United Kingdom	5
6	Rest of the world	59
*	Thailand	0.4

Source: International Cocoa Organization (ICCO), 2020

According to the current information from the International Cocoa Organization (ICCO) in 2020, the world's cocoa production is relatively contrasting to the world's cocoa import value. The main countries producing cocoa are not the main countries consuming their own products. Besides, most countries importing cocoa are considered the developed countries such as European countries and the U.S.A., and the most countries producing cocoa are considered either the developing countries or less developing countries. However, Indonesia, the only country in Asia, significantly shows the most cocoa production among the top list of the World's cocoa production in 2020. As the researcher, I expect that

many Asian countries possibly grow more cacao trees towards the world demands. Especially Thailand was named the kitchen of the world where there are many agricultural products supporting the world food market. And according to the cocoa belt countries, Thailand locates in one of the best cacao-growing lands along the equator line. Significantly, from the research on roasted cocoa beans between Thailand and Taiwan, there was a potential opportunity for processing better quality Thai craft chocolate products. (Piankarn et al., 2019).

Objective

The objective of this study was to sensory evaluation using Quantitative Descriptive Analysis (QDA), as follows: aroma, acidity, bitterness, astringency, defects, flavor, and aftertaste, of craft chocolate bars from 4 plantations (Chiang Mai, Chantaburi, Prachaup Khirikahn, and Chumphon Province) and produced from Private Craft Chocolate Company in Thailand.

Literature Reviews

According to the origin of Thailand's cocoa history, cocoa trees were introduced to Thailand in last 6 decades. Initially, the cocoa cultivar of Chumpon 1 Hybrid was introduced to southern Thailand (The Kamkav Farm, 2020). Until recently, Chumpon 1 Hybrid cultivar is commonly cropped the large numbers over the country. In addition, the cocoa cultivar of I.M.1 Hybybrid was introduced to northern Thailand in 2015, and it was mostly cropped among the group of farmers in the north of the country (La-Ongsri, 2015). Within the last couple of years, the nunumberf domestic cocoa beans are gradually increasing since Thai cocoa farmers have been cropping cacao trees all over Thailand. Therefore, it can be advantageous as a potentially large sosourceraft chocolate. The majority of Thai cacao trees were firstly grown in the Chumphon province in the south of Thailand, and along with growing further in the northern region. Currently, the researcher has studied about quality of harvesting cacao trees in Thailand. In this study, every single origin of craft chocolate is from Chiang Mai, Chantaburi, Prachaup Khirikahn, and Chumphon. Hopefully, the cacao farming will be larger scales than before due to the increasing demands of a quality craft chocolate products. The craft chocolate stores in Thailand are gradually increased mainly in Bangkok area and other big cities, for examples; Paradai Chocolate, Kad Kokoa, Kanvela, Aimmika Chocolate, Siamaya, Chocolate, Chocolate, and so on. Especially from Paradai Chocolate, Kad Kokoa, and Kanvela, in 2021 the craft chocolate products were awarded from the Academy of Chocolate Award (AOC) and the International Chocolate Awards (ICA).

Nowadays, increasing numbers of chocolate consumers in Thailand consider the occurrence of Thai craft chocolate. According to Thailand Craft Chocolate Festival (TCCF), in 2020 there are 12 Thai craft chocolate brands, 94 Thai craft chocolate brands in 2021, and 136 Thai craft chocolate brands in 2022. Consequently, the craft chocolate situation in Thailand gradually expands into the domestic chocolate market. This phenomenon introduces the chance of chocolate consumers in Thailand to have new perceptions of Thai craft chocolate flavor. The craft chocolate flavor consists of many compounds whose formation depends on the genetic profile of the cocoa from different areas. Since cacao trees were grown in different environments and cocoa beans were processed in different methods used, these will bring a complex chocolate flavor. According post-harvest procedures, such as fermentation, drying, and chocolate processing (roasting of the beans and conching of chocolate), these processes significantly influence the flavor of chocolate. Craft Chocolate is defined as the product obtained from a mixture of cocoa derivatives (*Theobroma cocoa L.*), which are cocoa mass and cocoa butter, mixed with sweetness from granulated sugar or other types of sugar. The use of different types of cocoa beans can result in differences in the sensory characteristics of chocolate. The quality and flavor of chocolate typically depend on the origin of the cocoa beans. In addition, the proportions of the ingredients used

in chocolate can create a variety of flavors regarding consumers' preferences. Especially the processing methods of chocolate can differ according to consumers' preferences and the practices of the chocolate producer (LANZA et al., 2011). Sensory analysis is a powerful scientific tool that can be used to identify differences in sensory attributes and assess a product's acceptability. In chocolate research, it can be beneficial to use descriptive sensory methods. Quantitative Descriptive Analysis (QDA) is a sensory method that can be used to provide a detailed description of the sensory characteristics of a product (STONE; SIDEL, 2004). According to QDA, all detectable aspects of a product are described and listed by a trained panel under the guidance of a panel leader. The list is used to evaluate the product, and the panelists quantify the sensory aspects of the product using an unstructured scale (SVEINSDÓTTIR et al., 2010).

Methods

Four chocolate samples were evaluated (containing 70% cocoa liqueur). The samples were obtained from Chumpon 1 Hybrid cultivar cropped in the different plantations in Thailand. Each of them originated from Chiang Mai, Chantaburi, Prachaup Khirikahn, and Chumphon Province. The craft chocolates were made using the following proportions: cocoa paste (70%), and granulated sugar (30%). The chocolates were manufactured in a private of craft chocolate factory in Bangkok, Thailand. Tasting form instructions of the Cacao Sensory Analysis were used to describe the differences and similarities among the chocolate samples obtained from four different cocoa plantations. Fifteen candidates were prescreened on the basis of their availability, general food habits, their ability to participate in group discussions, their ability to discriminate differences between products and their ability to describe their perceptions. The fifteen candidates were given four training sessions over a period of 2 days. Sensory descriptors for aroma, acidity, bitterness, astringency, defects, flavor, and aftertaste were developed through brainstorming about the similarities and differences among the craft chocolate samples. The next step consisted of the development and definition of each descriptive term under the supervision of a leader, aiming to join similar descriptive terms and to produce reference samples using round-table consensus (Table 3). The training was finished when the fifteen individuals had no difficulty in evaluating the samples using the descriptive evaluation form.

Sensory Profiles of Chocolates Produced from Cocoa Cultivars

Table 3: Sensory descriptors, definitions, and reference materials were used during panel training and quantitative descriptive analysis sessions. (USAID, Equal Exchange and, TCHO, 2018)

Sensory Descriptors	Definition and Reference Materials
Aroma	Smell the sample. Mark the intensity of the aroma on the first scale, write any characteristics that you find in the notes section, and score the quality. Remember that a low intensity or even absence of aroma does not imply lower quality.
Acidity	The relationship between intensity and quality varies depending on the perception and description of the acids that the taster finds during the evaluation. For example, if the taster perceives a citric or fruity acid, the score may be higher than if the acidity is more like vinegar (acetic acid).
Bitterness and Astringency	These are inherent characteristics of cacao, but the level of intensity can influence the quality, and there is often an inverse relationship. For example, a bitterness level that is 'Clearly Present' with an intensity of 2, might have a score between 'Good' and 'Excellent' in quality; while a higher intensity of bitterness may decrease the quality.

Table 3: Sensory descriptors, definitions, and reference materials were used during panel training and quantitative descriptive analysis sessions. (USAID, Equal Exchange and, TCHO, 2018) (Cont.)

Sensory Descriptors	Definition and Reference Materials
Defects	Increased intensity of defects means a lower score in quality. For example, if you find a strong flavor such as dirt that is 'Dominant' with an intensity of 4, your quality score will likely be between 'Terrible' and 'Bad'. If the sample is clean or free of defects, it should be scored as 'Excellent' in quality.
Flavor	The taster need only evaluate the characteristics that are perceived, as not all can be found in every sample. The quality score is based on a combination of factors including the harmony, clarity and complexity of the flavors.
Aftertaste	The residual flavor is left in the mouth after the sample has dissolved completely.

The sensory evaluations of the samples were conducted on the Cacao Sensory Analysis Tasting Form. The chocolate samples (2.5 g) of each single-origin were placed in a sealed plastic bag codified with three-digit numbers and served at room temperature (22 °C). The samples were presented to the panelists using a balanced complete block statistical design in order to eliminate any serving order effect. The tests were conducted in the morning, at the Food Academy of Panyapiwat Institute of Management, using individual booths and white light. Between samples, it was recommended the use of filtered water for cleansing the palate. Fifteen panelists rated the intensity of each sensory descriptor for each sample, in the tasting form, using unstructured scales of 0-6, labeled on the second column with intensity terms. In addition, the panelists rated the quality of each sensory descriptor for each sample, in the tasting form, using unstructured scales of 0-10, labeled on the fourth column with quality terms. According to the stages of sensory analysis, there are 4 steps which the panelists can evaluate as the following steps;

1. Observe the appearance: color, brightness, etc. The panelists can take note of these observations in Comments and/ or take them into consideration for Taster's points

2. Smell the sample to evaluate the Aroma category. Use a clean and odor-free container during this part of the evaluation.

3. Taste the sample to evaluate the following categories: Acidity, Bitterness, Astringency, Defects, and Flavors. If the sample is solid, chew it gently, allowing it to slowly melt on the palate.

4. When the sample has been ingested and/or has been expiated, the panelists analyze residual flavors in the mouth for the aftertaste category.

In a final session, the QDA results were evaluated by statistic summary of the Cacao Sensory Analysis Tasting Form, the sources of variance being the samples and the panelists for each sensory descriptor, using the scales of the Cacao Sensory Analysis Tasting Form. This form contains two types of scales. The purpose of the Intensity Scale is to develop a flavor profile of the samples, while the Quality Scale helps to identify the sample's potential. Significantly, there is no direct relationship between intensity and quality, except in the case of Bitterness, Astringency, and Defects. Half points are permitted when scoring on either scale. The analysis of the sample will be distributed into several categories: aroma, acidity, bitterness, astringency, defects, flavor, and aftertaste. Each attribute is organized into five fields, evaluated as follows:

1. Intensity: the panelists can assess the intensity of the perceived attributes on a scale of 0 (absent) to 5 (extreme), half points are allowed.

2. Quality: the quality of each category is valued numerically, using a quality scale from 0 (terrible) to 10 (excellent). On this scale, the use of half points is also allowed.

3. Points: total points are valued numerically for quality, taking into account that in Defects and Flavor the quality points are doubled.

4. Final Score: this is the sum of all quality points obtained during the tasting. The maximum score is 100 points.

5. Taster's point: the taster's general impression and subjective quality score for the sample, taking into account all of the other categories of evaluation.

Results and Discussion

The results of the Cacao Sensory Analysis showed that the craft chocolate samples slightly differed from each other. Each single-origin of craft chocolate sample was evaluated as a result of intensity, quality, and final score from descriptors of aroma, acidity, bitterness, astringency, defects, flavor, and aftertaste.

Table 4: The Summary of the Cacao Sensory Analysis: Intensity of the attributes (Scale of 0 (absent) to 5 (extreme))

Plantation / Sensory Category	Chiang Mai	Chantaburi	Prachaup Khirikahn	Chumphon
1. Aroma	3	3	2	3
2. Acidity	3	3	3	2
3. Bitterness	2	2	2	2
4. Astringency	1	2	3	1
5. Defects	1	0	0	0
6. Flavor	3	3	3	3
7. Aftertaste	2	2	2	3

According to the Table 4, the intensity of each attribute was shown no significant difference. However, the aroma of the craft chocolate from Prachaup Khirikahn was lower than others. The acidity of the craft chocolate from Chumphon was lower than others. The astringency of the craft chocolate from Prachaup Khirikahn was the highest. The defects of the craft chocolate from Chiang Mai were the highest. The aftertaste of the craft chocolate from Chumphon was higher than others. The bitterness and flavor of all craft chocolate samples were on the same scale.
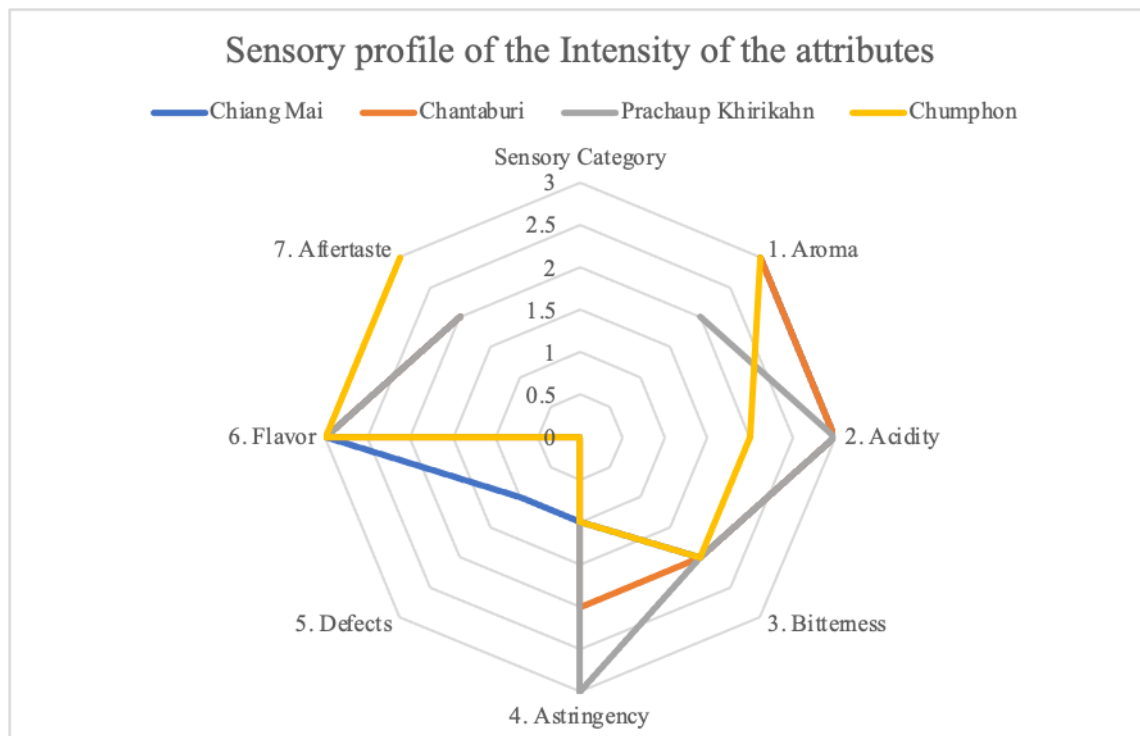
Figure 1: Sensory profile (Intensity of the attributes) of the craft chocolate samples
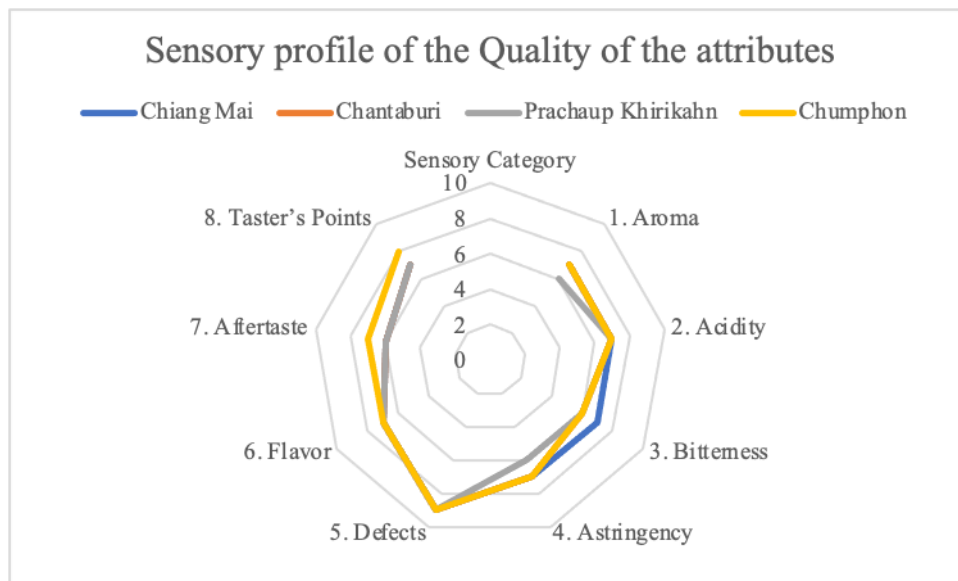from Chiang Mai, Chantaburi, Prachaup Khirikahn, and Chumphon.

Figure 1 graphically displays the intensity profile of the attributes of each craft chocolate sample. The zero point of the descriptor scale is the center, with the intensity increasing toward the extremities of the figure. The mean value of each descriptor for each sample is marked in the corresponding axis, and the sensory profile is drawn by the connection of the points. Each graph mostly illustrates similarly, except the craft chocolate from Prachaup Khirikahn and Chumphon displays slightly different from others.

Table 5: The Summary of the Cacao Sensory Analysis: Quality of the attributes (Scale of 0 (terrible) to 10 (excellent))

Plantation / Sensory Category	Chiang Mai	Chantaburi	Prachaup Khirikahn	Chumphon
1. Aroma	7	7	6	7
2. Acidity	7	7	7	7
3. Bitterness	7	6	6	6
4. Astringency	7	7	6	7
5. Defects	9	9	9	9
6. Flavor	7	7	7	7
7. Aftertaste	6	6	6	7
8. Taster's Points	7	7	7	8

According to the Table 5, the quality of each attribute was shown the similar the results as the intensity of the attributes (Table 4). However, the aroma and the astringency of the craft chocolate from Prachaup Khirikahn was lower than others. The bitterness of the craft chocolate from Chiang Mai was higher than others. The aftertaste and the taster's points of the craft chocolate from Chumphon was

higher than others. And the acidity, the defects, and the flavor of all craft chocolate samples were the same scale.
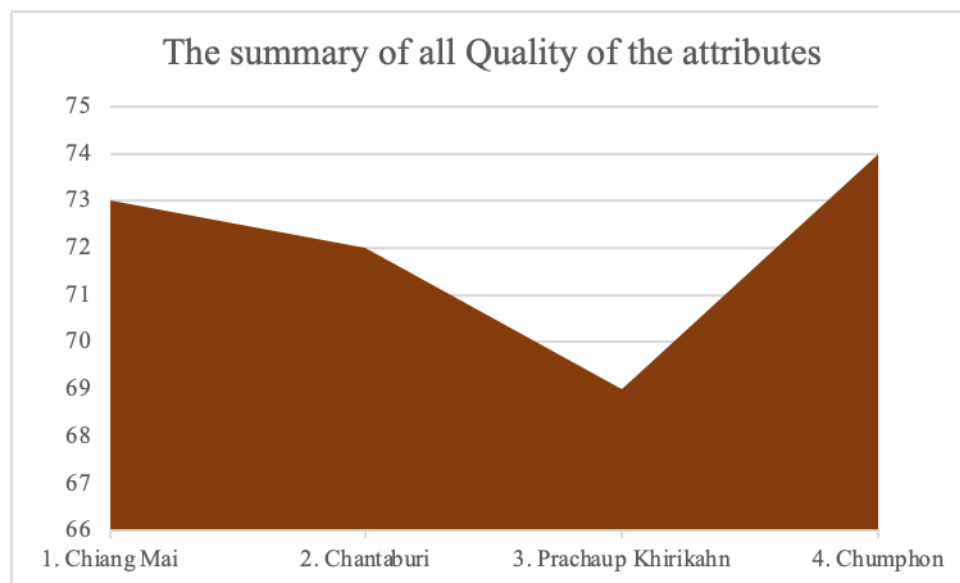

Figure 2: Sensory profile (Quality of the attributes) of the craft chocolate samples
from Chiang Mai, Chantaburi, Prachaup Khirikahn, and Chumphon Province

Figure 2 graphically displays the quality profile of the attributes of each craft chocolate sample. The zero point of the descriptor scale is the center, with the quality increasing toward the extremities of the figure. The mean value of each descriptor for each sample is marked in the corresponding axis, and the sensory profile is drawn by the connection of the points. Each graph mostly illustrates similarly, except the craft chocolate from Prachaup Khirikahn and Chumphon displays slightly different from others.

Table 6: The Summary of the Cacao Sensory Analysis: Final Score (The maximum score is 100 points)

Plantation		Final Score	Difference in %
1.	Chiang Mai	73	1.39
2.	Chantaburi	72	0
3.	Prachaup Khirikahn	69	4.17
4.	Chumphon	74	2.78
	The Average score	**72**	-

According to Table 6 and Figure 3, the final score of the Cacao Sensory Analysis was presented in the same amount score. The score results were calculated as 74 for Chumphon, 73 for Chiang Mai, and 72 for Chantaburi, except Prachaup Khirikahn, which scored the lowest of 69. In addition, the average score of the Cacao Sensory Analysis is 72, and the difference of each sample's final score is less than 5%. However, there is no significant difference among craft chocolate samples.

Figure 3: Sensory profile (the summary of Quality of the attributes) of the craft chocolate samples from Chiang Mai, Chantaburi, Prachaup Khirikahn, and Chumphon Province

Conclusions

The craft chocolate bars from 4 plantations produced from private craft chocolate company in Thailand were analyzed by the Cacao Sensory Analysis Form. The results showed no statistically significant difference of the intensity of each attribute among all craft chocolate samples. In addition, the sensory profile of quality of each attribute was calculated and presented similar scores for all samples. The sensory profile of all craft chocolate samples showed no statistically significant difference of taste and quality. Consequently, all craft chocolate samples from 4 different plantations in Thailand were presented as similar standard according to taste and quality. Each craft chocolate in Thailand has slightly different sensory profile due to different plantation, however most of them keep the similarity of the sensory profile. In addition of the further study, the researcher suggests finding the best practices of each craft chocolate processing and finally applying significant technique to each of craft chocolate production in order to enhance the sensory profiles.

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