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Food Science

DEVELOPMENT OF FURIKAKE FROM COCONUT WORM

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Abstract

This study aimed to develop rice-seasoning or furikake product from coconut worm and evaluate the acceptance testing of the developed product. Firstly, sample preparation methods (whole worm, worm with entrails removal and ground worm) and drying condition (120ºC and 170ºC) were studied. It was found that the worm needed to be cut and remove its entrails or ground before drying. At the same drying condition, moisture content of whole worm (30.87-39.80%) was much higher than that of cut worm without entrails (16.14-21.57%) and ground worm (3.21-12.54%). The most suitable preparation method and condition was to ground the raw worm before drying at 170ºC for 10 minutes because the sample had the lowest moisture content of 3.21% (could be characterized as dried food) and took less time. Dried ground worm was then used as the main ingredient for furikake product. Two recipes of furikake from coconut worm which were recipe 1: Tomyum and Mala flavor and recipe 2: Mala Flavor were developed. The results showed the participants preferred recipe 1: Tomyum and Malaflavor. Thus furikake developed from recipe 1 was tested for consumers' acceptance in terms of color,appearance, flavor, texture, taste and overall liking by using 9-point hedonic scale with 50 participants.The results of acceptance testing of the developed product were 8.04 ± 0.78 of color, 8.07 ± 0.84 for appearance, 8.14 ± 0.78 for flavor, 8.16 ± 0.84 of texture, 8.24 ± 0.82 of taste and 8.06 ± 0.79 of overallliking and 100% of participants accepted the developed product. This indicated that the developed furikake from coconut worm had a potential to be commercial in food market.

Keywords: Furikake rice seasoning coconut worm insect

Introduction

Edible insects have been an alternative source for feed and food. They are knows as a sustainable, alternative protein source for the future (Gjerris, Gamborg, & Röcklinsberg, 2016). There are various studies focusing on the popularity of insect-eating. It was found that Mexico, Brazil, Ghana, Thailand, China,and the Netherlands are some of the countries where insect-eating is most widely accepted today (Gjerris, Gamborg, & Röcklinsberg, 2016; Chufei et al., 2019).

However many people feel uncomfortable eating insects like other foods because they feel dislike, disgust, or fear toward eating insects with their original appearance (Chufei et al., 2019). In order to overcome this limitation, food products from insects presented in the shape of foods that people are familiar with should be considered (Tan et al., 2015; Hartmann, Ruby, Schmidt, & Siegrist, 2018).

In this study, development of Japanese-style rice seasoning or Furikake was focused. Furikakeis popular worldwide at the present. This product can enhance flavor and taste in our meal by topping on food especially steamed rice. Furikake usually consists of dried seaweed, roasted sesame seeds, driedfish, salt, monosodium glutamate (MSG) and sugar (Mouritsen, 2009). Nutritional value of furikake is easily improved by adding high nutrition ingredients such as vegetables powder and protein powder (Osimani et al., 2018). Up until now, there is no furikake product that its nutritional value is improved by addition of insects. Furikake was considered in this study also because the original appearance of insectis not existed in the product.

Worm from Rhynchophorus ferrugineus or worm from Sago palm (sago palm-feeding) or coconut worm (coconut-feeding) weevil is one of the most popular edible insects in Thailand and many regions (Liengpornpan & Liengpornpan, 2010). The worm has low feeding cost and short life cycle (about 40 days from egg to adult) (Liengpornpan & Liengpornpan, 2010). It was also have high protein content which is nearly 2 times higher than that in milk (Rattanapanont, 2011; Liengpornpan, 2012). Thus this kind of worm was used as the main ingredient for furikake development in this study. The knowledge of this study could be able to raise the value and utilization of coconut worm, a local edible insect, in food industriesand also create the business opportunity of food from insect.

Research objectives

1. To develop furikake product from coconut work
2. To study acceptance testing of the developed furikake product from coconut worm

Literature review

1. Food drying

Drying is a process of foods dehydration until there is not enough moisture to support microbialactivity (Devahastin, 2012). Drying removes the water that bacteria, yeasts, and molds needed for growth and also deceases chemical reaction activities (Devahastin, 2012). During drying, heat and masstransfer occurs simultaneously. Heat penetrates to food from outside to inside and make the temperaturerises. When temperature of water in food reach the boiling point, water vapor will evaporate from the food surface (Mujumdar, 2007). Due to its low moisture content, dried foods normally have long shelflife. Therefore, drying was taken in to account in this study because this process would provide the desired product characteristic of furikake which was dried product with long shelf life.

There are several methods for food drying for example hot air drying, sun drying, microwave drying and freeze-drying. Each method gives different transport phenomena in food during heating andgives different food characteristics (Mujumdar, 2007; Devahastin, 2012). In this study, hot air drying, the simplest commercial drying method, would be applied in the beginning experiment.

2. Nutritional value of worms

Up until now, there are many research works focusing on nutritional value of edible insects. Normally, it was found that many insects contain high nutritional value such as protein, saturated fattyacids and vitamins (Stoopsac, et al., 2017). In Thailand, worm from Rhynchophorus ferrugineus or worm from Sago palm weevil is one of the most popular edible insects in many regions (Liengpornpan & Liengpornpan, 2010). In 2012, Supanee studied the nutritional value of worm and food plant tissue (gebangpalm and sago palm) used in the worm feeding (Table 1 and 2). It was found that nutritional value of worms related to their feed. It was also noticed that protein content of worms was much higher than protein in milk of 3.40% (Rattanapanont, 2011).

Table 1: Nutritional value of worms from gebang palm and sago palm

Nutritionalvalue	Analysis	Results	
		Worm from gebang palm	Worm from sago palm
Crude protein	AOAC (Kjeldahl Method)	7.97%	6.88%
Carbohydrate	Calculation	4.70%	4.24%
Total fat	AOAC (Acid Hydrolysis Method)	20.13%	18.71%

Table 1: Nutritional value of worms from gebang palm and sago palm (Cont.)

Nutritionalvalue	Analysis	Results	
		Worm from gebang palm	Worm from sago palm
Energy	Calculation	231.85 Kcal	212.87 Kcal
Chloresterol	GC	19.00 mg/100 g (wb)	16.37 mg/100 g (wb)
Moisture	AOAC (Loss on Drying at 95-100ºC)	66.43%	69.44%
Ash	AOAC	0.77%	0.73%

Source: Supanee, 2012

Table 2: Nutritional value of gebang palm tissue and sago palm tissue (Supanee, 2012)

Nutritional value	Analysis	Results	
		Gebang palm tissue	Sago palm tissue
Crude protein	AOAC (Kjeldahl Method)	1.47	0.62
Crude fiber	AOAC (Fritted Glass Crucible Method)	8.01	0.00
Crude fat	AOAC (Soxhlet Extraction Method)	0.15	1.31
Moisture	AOAC (Loss on Drying at 95-100ºC)	45.82	53.42
Ash	AOAC	1.23	1.55

Source: Supanee, 2012

2. Research on furikake development

Rice seasoning or “Furikake” in Japanese is a traditional product originated in Japan, which ispresently popular worldwide. It is used as a topping over worm rice, soup and other dishes (Mouritsen,2009). Due to its popularity, there are some research works focusing on furikake development from high nutrition ingredient and even local ingredients. However, there is no furikake developed from theworm of Rhynchophorus ferrugineus up until now.

Kaewsritho and co-workers (2018) developed Tom Yum flavored rice seasoning from vegetable powder which contained high dietary fiber and antioxidant activity. Three levels of vegetables powder (16, 18 and 20% (w/w)) were varied. Sensory evaluation was done by using 9-point hedonic scale and just-about-right with 30 untrained panelists. It was found that rice seasoning with 20% vegetable powder was the appropriate amount. In addition, moisture content and water activity (a_w) of the developed product were analyzed and found that they were in the safe for consumption criteria.

Recently, Rajchasom and co-workers (2020) developed a new furikake product from a northernlocal fermented soy bean. The nutritional value, chemical component and antioxidant of the products were analyzed. It was found that the best ratio of the dried fermented soybean powder was 35%. The panelists moderately liked the products with overall acceptable score of 7.46 ± 0.67 and 7.44 ± 1.01 forfurikake in sesame-seaweed and garlic flavors, respectively. The furikake with sesame-seaweed had protein, fat and antioxidant of 29.90%, 9.72% and 1.79 µmol TE/g, respectively. The furikake with garlic flavor had protein, fat and antioxidant of 31.70%, 20.51%, 1.96 µmol TE/g, respectively.

Methodology

1. Study of suitable sample preparation method and condition

Three sample preparation methods and conditions as follows were studied in order to achieve the most suitable ones by consideration of moisture content of final samples.

Method 1 Whole worm with entrails: The whole worms without entrails removal were cleaned,stir-fried for 10 minutes and dried in an oven (120 ºC and 170 ºC for 120 and 300 minutes for each temperature). After drying, they were ground by using a food blender at medium rotation level for 3 minutes. After that the ground worm was dried again in an oven at 170ºC for 10 minutes.

Method 2 Worm without entrails: The entrails was removed from the worms before stir-frying,drying and grinding in the same way as method 1.

Method 3 Roasted ground worm: The whole worms were cleaned and then stir-fried for 10 food blender at medium rotation level for 3 minutes. Afterthat it was spread as very thin sheet on a try and dried in an oven at 120 ºC and 170 ºC for 10 and 20 minutes for each temperature. Then it was ground again.

2. Development of furikake from coconut worm

Two recipes, with and without Tomyum flavor, were compared in this study (Figure 1 and Table 3) and were evaluated by sensory evaluation in terms of color, flavor, appearance, texture, tasteand overall liking.

(a)

(b)

Figure 1: Furikake recipe 1: with Tomyum flavor (a) and recipe 2: without Tomyum flavor (b)

Table 3: Two developed furikake recipes, with and without Tomyum flavor

Ingredients	Recipe 1: With Tomyum flavor (%)	Recipe 2: Without Tomyumflavor (%)
Dried ground worm	40.00	40.00
Tomyum seasoning	13.33	-
Dried ground Tomyum herbs	1.33	-
Mala seasoning	13.33	28.00
Chili powder	4.00	4.00
Mushroom powder	13.33	13.33
Roasted white sesame	4.00	4.00
Roasted black sesame	4.00	4.00
Ground sugar	6.67	6.67

1. Sensory evaluation of the developed furikake from coconut worm

In this section, 50 participants were participated to answer 3 parts of questionnaires:

Part 1 General information of participants (gender, age, occupation, incomes)

Part 2 Consumer behavior for furikake product (brand, frequency, expense)

Part 3 Consumer acceptance in the developed product. The 9 - point hedonic scale was appliedin this section in order to collect the responses (Color, texture, appearance, flavor, taste, overall) from the participants (Wichchukit & O'Mahony, 2014). The main characteristics of the scale are that each category is associated with a verbal descriptor from "dislike extremely" to "like extremely" (Wichchukit and O'Mahony, 2014) at which

1 = dislike extremely	2 = dislike very much	3 = dislike moderately
4 = dislike slightly	5 = neither like nor dislike	6 = like slightly
7 = like moderately	8 = like very much	9 = like extremely

The average score and standard deviation were calculated and revealed in results section.

In this section, the participants were served with the worm steamed-rice topped with thedeveloped furikake (Figure 2).

Figure 2: Sensory evaluation

Results and discussion

1. Study of suitable sample preparation method and condition

From Table 4, it was found that sample preparation methods affected moisture content of samples after drying. Moisture content of whole worm with entrails were still high after drying for all conditions while those from worm without entrails were much lower. During the preparation step, it could be noticed that the entrails were wet and oily and also the dried outer worm skin might block the drying phenomena. This situation could be explained tin the same way as bread crust formation duringdrying at which water vapor was evaporated from the bread skin and the case hardening that the evaporation happened (Jeffersona, Laceya, & Sadd, 2006). Thus, to remove the entrails before drying gave much better results, in terms of short time and nearly 50% lower moisture content, because the initial moisture content of worms before drying were lower. However, in order to prove this assumption, chemical composition of whole worm with entrails and worm without entrails should be further studied and addressed in our future publication. Moreover, both whole worm with entrails and worm without entrailswere time consuming during drying process.

Not only preparation method, but drying condition also affected the moisture content of samples. The results indicated that sample dried at higher temperature and longer duration gave the lower moisture content. After drying for 300 minutes at 120 ^{o}C and 170^{o}C, moisture content dwhole worm with entrails were 36.04% and 30.87%, respectively and worm without entrails were 18.05% and 16.14%, respectively. Noteworthy, worm without entrails with drying condition of 120 ^{o}C and

170ºC for 300 minutes could give the intermediate moisture food or IMF product, a shelf-stable product with moisture contents typically ranging from 10-20% (Jay, 1998). Moisture or water content is a measurement of the total water contained in a food product, usually expressed as a percentage by weight on a wet basis. This value is related to water, which is considered to be the mostcritical factor for microbial growth (Mujumdar, 2007; Devahastin, 2012), through the moisture sorptionisotherm at a given temperature and humidity. In order to be characterized as dried food or dehydrated food at which the activities of food spoilage and food-poisoning microorganisms are inhibited, the moisture content and water activity must be approximately lower than 10% and 0.60–0.65, respectively, depending on the type of food (Mercer, 2008). In this research, roasted ground worm dried at 170ºC for 10 minutes was used for further study on furikake development because its lowest moisture content of 3.21% which reached the criteria of dried food (less than 10%) with less time consumed. However, ground worm dried at 170ºC for 20 minutes was overheat and this condition was not considered in this study.

Table 4: Moisture content of samples with different preparation method and condition

Sample preparation	Temperature (ºC)	Time (min)	Moisture content (% wet basis)
Whole worm with entrails/Dry/Grind	120	120	39.80
		300	36.04
	170	120	35.92
		300	30.87
Worm without entrails/Dry/Grind	120	120	21.57
		300	18.05
	170	120	18.41
		300	16.14
Roasted ground worm	120	10	12.54
		20	9.45
	170	10	3.21
		20	Overheat (burn)

2. Development of furikake from coconut worm

During the experiment, unpleasant odor (wood and worm) was of the roasted ground worm noticed after drying. Thus, pungent herbs were considered to develop the furikake from coconut wormfor they were used in food with unpleasant odor in order to achieve better sensory perception (Potter & Hotchkiss, 1998). Tomyum and Mala seasoning were used in this research because of their popularity at the present. Mala is the combination of Sichuan peppercorns (ma) and dried chilies (la). It produces a strange, tingling, buzzing, numbing sensation (Ji, Li, & Ho, 2019). It is used in a variety of ways such as stir-fry, stews, soup, hot pot and dipping sauce. Because of its unique strong and strange flavor, it has become one of the most popular ingredients in Chinese cuisine and many countries including Thailand. In this study, two recipes, with and without Tomyum flavor, were compared (Figure 1). Both two recipes were evaluated by sensory evaluation in terms of color, flavor, appearance,texture, taste and overall liking. It was found that the most accepted was recipe 1 which contained Tomyum flavor for all attributes while recipe 2 (without Tomyum flavor) gave lower liking score in terms of flavor and taste (data not show). The participants suggested that recipe 2 which contained onlyMala seasoning about 2 times higher than recipe 1 (Table 3), gave too much pungent flavor and test ofMala while Tomyum flavor in recipe 1 gave the mouth-watering feeling, especially the lime-flavor. These suggestions were in agreement with the research work of Boonbumrung (2011)

who study on aroma functional properties of Thai Tom Yum essential oils. It was found that 1,8-cineole, geranial citronellaland linalool were the potent aroma contributed to camphoraceous , citrus , sweet floral aroma. The supplement odorants were neral, 3-methyl butanal, β-ocimene, citronellol and myrcene with citrus, green, floral, sweet balsamic, herbaceous and terpene like. These odorants represented the uniqueness of Tomyum and enhanced the mouth-watering feeling (Boonbumrung, 2011). Moreover, the participants suggested that sugar should be fine enough to not be able to see by eyes otherwise it looked like the fruit-dips from chili and salt. Thus the recipe 1 (Figure 3) was improved and used for further study onthe Sensory evaluation section.

Figure 3: Product from recipe

3. Sensory evaluation of the developed furikake from coconut worm

In this section, 50 participants were participated. In terms of general information, the participants were 27.50% of male and 72.50% of female. Most of them were 60.80% in the age between 15-20 years, 96.10% of students and 98.00% of them had incomes lower than 15,000 Baht (data not show).

In terms of consumer behavior for furikake (data not show), participants selected such furikakebrands as 25.50% for Mishima, 15.70% for Marumiya, 9.80% for Yamu, 1.80% for Saijai and 47.20% for others. It was also found that eating frequency of furikake product was 39.20% for 1-2 times/month, 7.80% for 3-4 times/month, 4.40% for 5-6 times/month, 1.50% for every day and 47.10% for less than1-2 times/month. The expenses for furikake product were 47.1% for lower than 41 Baht, 17.60% for 41-50 Baht, 21.60% for 51-60 Baht, 7.80% for 61-70 Baht and 5.90% for more than 70 Baht.

For consumer acceptance testing of the developed product, the liking score of all attributes were8.04 ± 0.78 of color, 8.07 ± 0.84 for appearance, 8.14 ± 0.78 for flavor, 8.16 ± 0.84 of texture, 8.24 ±

0.82 of taste and 8.06 ± 0.79 of overall liking (Table 5) and 100% of participants accepted the developedproduct (Table 6).

Table 5: Consumer acceptance in the developed product

Attributes	Average liking score
	Recipe 1
Color	8.04 ± 0.78
Appearance	8.07 ± 0.84
Flavor	8.14 ± 0.78

Table 5: Consumer acceptance in the developed product (Cont.)

Attributes	Average liking score
	Recipe 1
Texture	8.16 ± 0.84
Taste	8.24 ± 0.82
Overall	8.06 ± 0.79

Table 6: Product acceptance

Product acceptance	Percentage
Yes	100
No	0

Conclusion

Sample preparation method and drying condition had an important role in changes of samples moisture content. The most suitable preparation method and condition were grinding of worm before drying at high temperature. By using that way moisture content of sample was as low as 3.21% with 10 minutes drying at 170°C. For the furikake recipe development, Tomyum and Mala flavor was favored over another one of Mala only. This implied that Tomyum flavor, a familiar Thai style flavor with the mouth-watering feeling, has still attracted consumer attention. Moreover, the developed furikake product from coconut worm could be a new face product from insect in food market because of the liking scores and acceptance from consumers. However, nutritional value of the developed product and cost analysis should be further studied in order to obtain more information for marketing plan and analysis.

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SENSORY EVALUATION OF HIGH PROTEIN GELATO FROM CRICKET

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Abstract

Cricket has a high potential for Thailand due to the sustainable food trend. The world is eager for sustainable protein sources, and cricket gelato from almond milk is an opportunity for the consumer who wants to consume healthy-high protein dessert and lactose-free. The sensory evaluation in 4 treatments (0% flavored syrup, vanilla, chocolate, and floral flavor) on hedonic 9 scale of untrained panelist. The results showed that chocolate cricket gelato was the highest color (7.05), flavor (6.20), taste (6.80), and overall acceptable score (6.82). The increase of cricket powder level (0%, 5%, 10% and 15%) affected the increase of crude protein, crude fat, and fiber. The appropriate formulation with high protein, overall acceptable score, and higher 70% Just About Right (JAR) was the 10% cricket powder. The chemical property of chocolate-cricket gelato with 10% cricket powder was 50.72% moisture content, 7.87% crude protein, 1.62% ash 14.74% fat, 10.33% fiber and 14.72%carbohydrate. The consumer acceptance of developed cricket gelato revealed that the developed chocolate-cricket gelato had overall acceptable at 7.04±1.10 (moderate liking) accepted by 90% of the target consumer, and 84% purchase intention. The protein source from cricket was successful for producing high protein gelato in healthy desserts and fit the target consumer needs.

Keywords: Cricket Powder, Cricket Gelato, High Protein Gelato, Sensory

Introduction

A growing population has been tremendously increasing from the last centuries (Roser, 2014). Altering diets is increasingly recognize as an important solution to feed the world's growing population. The potential of future foods, such as insects, seaweed or cultured meat has been trend continuously. The compared to current animal-source foods, future foods have major environmental benefits while safeguarding the intake of essential micronutrients. The complete array of essential nutrients in the mixture of future foods makes them good-quality alternatives for current animal-source foods compared to plant-source foods. The nutrient bioavailability and digestibility, food safety, production costs and consumer acceptance will define their role as main food sources in future diets (Parodi et al., 2018). The insects is one of future food based protein source (Skrobonja, 2019).

The eating of insects as an alternative protein source for human food and animal feed is interesting in terms of low greenhouse gas emissions, high feed conversion efficiency, and low land use. However, insects need to be processed and turned into palatable dishes. Furthermore, food safety and consumers' attitude are the main issues of an obstacle to encouraging people to consume (Huis, 2016). Crickets are incredibly rich in nutrients especially protein and all essential amino acids that are necessary to rebuild the muscles and tissues in our bodies. Cricket has 15% more iron than spinach, twice more protein than beef, and as much vitamin B12 as salmon. The study from Wang, Bai, Li, and Zhang (2004), showed that field cricket contained 58.30% of crude protein by volume and 32.25% of essential amino acids.

In contrast, red meats and chicken have been the main protein intake source for humans for centuries. Laboratory evidence showed there were 32.1g of protein per 100g in chicken breast and 28.7g per 100g in beef steak (Smith & Roussell, 2020). Edible crickets have been firstly domesticated in Thailand where 20,000 farmers produce 7,500 tons per year (Boonsong, 2013). They can be eaten whole by several cooking techniques including baked and fried. They also were transformed to powder for utilization in the various mixture, for instance, pasta, bread, cookies, snacks, smoothies, etc.

The use of insects as food and drugs has been using for a long time in both the western and eastern world. Nonetheless, to make them enough appetizing is still challenging. Crickets have been used as an ingredient in various types of food, for instance, appetizers, main entrée, and dessert. Ice cream is one of the most popular desserts that originated back in the 2nd century B.C. and had been developing and shaping up to how it looks like today in the 1700s (IDFA, 2021). Today, there are different types of dairy-based frozen desserts available in the markets: ice cream, frozen custard, frozen yogurt, and soft ice cream. The FDA requires a product to contain at least 10% milkfat to be called "ice cream." (Godman, 2019). Other ingredients include milk proteins; sugar; stabilizers and emulsifiers. Frozen custard consists of egg yolks. Frozen yogurt contains milk fermented with yogurt and gelato has less milk fat and air than normal ice cream. As for people's health concerns, chefs and nutritionists create alternative selections of ice cream recipes by using non-dairy milk like almond milk, coconut milk, soy milk, or cashew milk.

In this research, our team conducted an experiment and ways to develop a gelato recipe to achieve consumers' acceptance of consuming cricket in their daily lives. Ice cream has been selected to be the main diet for the development. Thailand's ice cream was valued at 35,514.1 million baht in 2016 and is forecasted to grow at a CAGR of 8.8% during 2016-2021. Per capita consumption of ice cream products stood at 1.95 kg which is higher than the average in the regional sector. (ASD Reports, 2017). Besides the deliciousness, ice cream has a substantial downside between those high sugar and fat contents that lead to fatal gastrointestinal issues. 105 grams of ice cream may contain up to 300 calories, 19 grams of fat (10 grams of saturated fat) which raises the level of LDL cholesterol.The American Heart Association (2018) recommends a daily limit of 25 grams of added sugar and 36 grams for women and men respectively, but a serving of ice cream contains about 23 grams of sugar. Consuming too much sugar in the diet can contribute to health problems like obesity and tooth decay (Better Health, 2011). On contrary, data shows low numbers in vitamins, iron, and magnesium.

Research objectives

1. To investigate the appropriate taste of cricket gelato
2. To investigate the appropriate cricket content level to develop high protein cricket gelato
3. To investigate the consumer liking and acceptance of developed cricket gelato

Literature review

The forecasted by 2050 the world's population will be up to 9 billion, so, one of the global problems may be amounts of food for increased population and in particular with adequate protein supply (FAO, 2012). Global environmental changes generate the need to search for new protein sources for human nutrition. For this reason, the Food and Agriculture Organization of the United Nations (FAO) recommends the consumption of edible insects because of their high nutritional value and environmentally friendly breeding conditions. Edible insects were popularly used to make protein food source in Africa, Latin America, or Asia. The over 1900 different species of insects were

consumed globally (FAO, 2012) . The methodology for increasing acceptability and insect consumption was concerned with safety farm and production. Some countries from European Union had regulated the production of insect-based foods. The global change in legislation in this area might contribute to the increase in insect consumption in Europe. Cricket (*Acheta domesticus*) was a rich nutritional source such as protein, essential fatty acid, vitamins, and minerals. The nutritional composition of cricket was depending on the species of insect, its development stage, species type (insect farm or caught in the forest). The protein content of cricket was varied from 13 to higher 77% of dry matter. Ecological and environmental conditions, processing of insects including heat treatment type such as boiling, baking, and roasting also significantly affect insect nutrition (Montowska, Kowalczewski, Rybicka, & Fornal, 2019).

The chemical composition of cricket (*Gryllus testaceus Walker*) was 58.30% crude protein, 10.30%crude fat, 8.50%chitin, 2.96%ash and 5.03%moisture on a dry matter basis, respectively. The high protein percentage of the cricket and the amino acid composition showed a suitable nutritional profile according to W.H.O. requirements, provided that the cricket was a high protein source for producing animal feed or food. The essential amino acid profile of cricket from FAO/WHO research, results showed a pattern of all amino acids except for cysteine and methionine. The fatty acid analysis showed unsaturated acid of the cricket to be present in high quantities, and the total percentage of oleic acid, linolic acid, and linolenic acid was 77.51 % . The chitin content of the insect was 8.5 % with better quality than the commercial chitin that was prepared from shells of shrimp and crab. Hence, the chemical composition of the cricket indicated the insect to be a good supplement to nutrition for food and feed, even a raw material for medicine (Wang, Bai, Li, & Zhang, 2014)

Gelato was developed in Italy, remains the biggest competition for ice cream. There were differences between ice cream and gelato appear, Italian gelato had little or no overrun, whereas ice cream overrun varies from 30% or less for super-premium ice cream to 95-100% for other types. Italian gelato didn't use stabilizers or emulsifiers that were mostly used to produce ice creams for increasing viscosity. Egg yolks composed of high nutritional values and multi-functional properties were used to serve multiple functions in food formulations. The various components could coagulate on heating, play the emulsifiers part in oil and water formulations, and when whipped they could create rich foams (Alfaif & Stathopoulos, 2004).

Almond milk was one plant-based milk that was popularly used to milk substitute for consumers suffering from milk allergy. The process for the development of plant-based milk alternatives using almond milk was very interesting. Almond was a source of nutrients composed of α-tocopherol (36.4%) that affected a pivotal role in free-radical reaction inhibition and oxidative stress prevention. Moreover, almonds were enriched with minerals like magnesium (19. 5%) , copper (16.0%), phosphorus (13.4%), and high fiber content (13.2%). The proximate composition of almond composed 25% of protein with excellently high arginine levels. The almond fat content was quite high (49. 4%) , however, it was especially characterized by a high level of MUFA (67%) which was especially advantageous for heart health. Furthermore, almonds also contained polyphenols and phytosterols such as β-sitosterol, stigmasterol, campesterol, sitostanol, and campestanol which could possess cardioprotective attributes (Kundu, Dhankhar, & Sharma, 2018).

Methodology

1. Investigation the appropriate taste of cricket gelato

The cricket powder was made with commercial crickets (*Gryllus testaceus Walker*) (Kwanjai farm, Thailand). The cricket was dried at 70°C for 8 hours in a tray dryer. The crickets were

milled in powder and passed through a 100-mesh sieve to obtain a fine powder. The cricket powder was kept in polyethylene bags and stored at -18°C before use.

The gelato as selected basic formulation was prepared in a pasteurizer-emulsifier mixing at 4°C: almond milk (55.37% w/w), non-dairy cream (20.06% w/w), honey (12.68% w/w), egg yolk (6.39% w/w), cricket powder (5% w/w) and thickeners (Carboxymethyl Cellulose: CMC (0.5% w/w)). In the pasteurizer, the mixture was heated up to 85 °C and then rapidly cooled to 4°C. An aging phase of about 10 h was carried out, keeping the mixture in slow stirring. During the aeration-freezing phase, the mixture was continuously stirred for 7-8 min at -8±1°C in an ice cream machine. Finally, the gelato was cooled and stored at -18°C.

The 4 flavored syrup including the control sample (0% flavored syrup), vanilla, chocolate, and the floral flavor was studied by substituted 12% syrup with almond milk in basic formulation except for only chocolate in the type of powder and fixed the amount of 5% cricket powder. The 40 grams of cricket gelato was scooped into an ice cream cup and covered with an ice cream lid. All samples were kept at -18°C in the freezer before further analysis. The product that could be covered the cricket smell with the highest liking score from the sensory evaluation was received.

1.1 Sensory evaluation

Sensory evaluation was conducted using 60 untrained panelists as target consumer who was asked to score appearance, color, flavor, taste, sweetness, oiliness, texture (homogeneously) and overall liking on a 9-point hedonic scale ranging from 1 (extremely dislike) to 9 (extremely like) (Feng and Mahony, 2017). The target consumer was 18-60 years old and not insect allergy willing to test cricket 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 ($P \leq 0.05$) between treatments. The mean values were compared using Duncan's New Multiple Range Test (DMRT) procedures. Statistical analysis of results was performed using a SPSS package (SPSS 12.0 for Windows, SPSS Inc., Thailand).

2. Investigation the appropriate cricket content level to develop high protein cricket gelato

From the selected flavor of cricket gelato in part 1, adding 4 level of cricket powder (0%, 5%, 10% and 15%) in formulation was studied the appropriate cricket content by substituted cricket powder with almond milk in formulation and then all samples was analyzed including chemical property and sensory evaluation as followed:

2.1 Chemical property of high protein cricket gelato

The determination of moisture, crude protein, crude fat, and ash was carried out according to the methods of AOAC (2000). Moisture was quantified by oven-drying at 105°C, total fat was evaluated by Soxhlet extraction, and crude ash by incineration in a muffle furnace at 550°C. Crude protein level was estimated from the total nitrogen amount by multiplying by a factor of 6.25 carbohydrate level (%) was calculated by the following equation: 100 - (moisture + crude protein + crude fat + ash).

2.2 Sensory evaluation of high protein cricket gelato

Sensory evaluation using 60 untrained panelists as target consumer was studied. Target consumer were asked to liking score appearance, color, flavor, taste, sweetness, oiliness, texture (homogeneously) and overall liking on 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).

2.3 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 ($P \leq 0.05$) between treatments. The mean values were compared using Duncan's New Multiple Rang Test (DMRT) procedure. Statistical analysis of results was performed using a SPSS package (SPSS 12.0 for Windows, SPSS Inc., Thailand).

3. Investigation the consumer liking and acceptance of developed cricket gelato

The 200 untrained panelist (target consumer), 18-60 years old and not insect allergy was conducted at Panyapiwat Institute of Management in partitioned sensory booths and evaluated questionnaire dived into 2 parts as followed:

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

Part2: Consumer liking and acceptance of developed cricket gelato

For sensory evaluation, 200 untrained panelists are used to determine appearance, color, flavor, taste, sweetness, oiliness, texture (homogeneously) and overall liking on 9-point hedonic scale ranging from 1 (extremely dislike) to 9 (extremely like) (Feng & Mahony, 2017) and consumer acceptance on developed cricket gelato (suitable price and purchase intent). The population size design of this study used consumer acceptant tests that provided the sample size of 60 or more for power calculations conducted following the method of ISO 8587: 2006 in the topic of sensory analysis - methodology - ranking (Birol, Meenakshi, Oparinde, Perez, & Tomlins, 2015).

Results and discussion

1. Investigation the appropriate flavor and taste of cricket gelato

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 flavor affected the consumer liking score, and resulted in the highest color (7.05), flavor (6.20), taste (6.80), and overall liking score (6.82) in chocolate cricket gelato ($P<0.05$). For floral cricket gelato, this treatment had the second highest texture (6.05) and overall acceptable score (6.38) after chocolate cricket gelato. The results could explain that the chocolate powder was dark brown, so it could be covered up the color of the cricket powder making the color consistent in gelato. This result agreed with Zampini, Sanabria, Phillips, and Spence (2007), finding in color effects on consumer perceived flavor characteristics. As for the oiliness attribute, the vanilla flavor had the highest liking score (7.00) ($P < 0.05$), however, the vanilla flavor and the chocolate flavor were not significantly different from the oiliness attribute. All samples attribute consist of appearance, sweetness, and texture (homogeneously) weren't significantly different ($P \geq 0.05$). Hence, cricket gelato would be a chocolate flavor to fit target consumer needs and this treatment was selected for the next experiment.

Table 1: Sensory evaluation of varied flavor and taste of cricket gelato

Attribute	Control (0% syrup)	Vanilla syrup	Chocolate powder	Floral syrup
Appearance^{NS}	6.40±0.55	6.20±0.84	6.40±0.75	6.20±0.84
Color	5.30^{b}±1.02	5.48^{b}±1.00	7.05^{a}±0.84	6.18^{ab}±0.71

Table 1: Sensory evaluation of varied flavor and taste of cricket gelato (Cont.)

Attribute	Control (0% syrup)	Vanilla syrup	Chocolate powder	Floral syrup
Flavor	5.00 ^{b}±0.71	6.00^{a}±0.71	6.20^{a}±0.45	6.20 ^{a}±0.84
Taste	4.40^{c}±0.55	5.40^{b}±0.85	6.80^{a}±0.82	6.60^{a}±0.55
Sweetness^{NS}	6.00±0.71	6.40±1.14	6.60±1.14	6.40±0.55
Oiliness	5.20^{c}±0.84	7.00^{a}±0.71	6.40^{ab}±0.55	5.80^{bc}±0.84
Texture (homogeneously) ^{NS}	**5.60**±0.55	**5.60**±1.14	**6.20****±0.65	**6.05****±1.08
Overall acceptable	4.80^{c}±0.95	6.20^{b}±1.14	6.82^{a}±0.78	6.38^{b}±0.85

^{NS} Means within the same row are not significantly different (P≥0.05).
$^{a-c}$ Means within the same row with different letters are significantly different (P<0.05).

2. Investigation the appropriate cricket content level to develop high protein cricket gelato

The chemical attributes were measured in terms of proximate composition (moisture content, crude protein, ash, crude fat, fiber, and carbohydrate). The chemical property (Table 2) showed that the increase of cricket powder affected the increase of crude protein, crude fat, and fiber. According to the research of Wang, Bai, Li, and Zhang (2014) revealed that the chemical composition of cricket powder was 58.30% crude protein, 10.30% crude fat, 8.50% chitin, 2.96% ash and 5.03% moisture on dry matter basis. This result occurred from the cricket powder as raw material which had mainly protein and fiber source in gelato. The major for development of high protein gelato using alternative protein source from cricket, and almond milk replacement to cow milk is a good choice not only high protein but also lactose-free ingredient source to produce gelato.

Table 2: Chemical property of high protein cricket gelato

Component chemical (g/100g)		Control (0% Cricket powder)	5% Cricket powder	10% Cricket powder	15% Cricket powder
Moisture content		70.63	62.41	50.72	40.95
Crude protein		1.94	5.02	7.87	10.08
Ash		0.15	0.92	1.62	1.97
Crude fat		11.20	11.25	14.74	17.06
Fiber		1.28	5.54	10.33	15.10
*Carbohydrate		14.80	14.86	14.72	14.84

*Carbohydrate level (%) was calculated by the following equation: 100-(moisture + crude protein + ash + crude fat +fiber).

From the study of appropriate cricket content level to develop high protein cricket gelato, the results showed that different cricket content levels affected on liking score as shown in Table 3. All samples attribute consist of color and oiliness weren't significantly different (P≥0.05). The cricket gelato with 0% and 10% cricket powder, had the highest overall liking score with no significant difference (6.32, 6.11). Overall acceptable scores tended to decrease with increasing cricket powder, especially at the highest concentration (15%). This may be because untrained panelist were less

accepting of strong cricket flavor. When comparison with chemical property, the cricket gelato with 10% cricket powder was selected due to higher protein and overall liking score than the control sample (0% cricket powder).

Table 3: Sensory evaluation of chocolate-cricket gelato with varied cricket powder level

Attribute	Control (0% Cricket powder)	5% Cricket powder	10% Cricket powder	15% Cricket powder
Appearance	7.11^{a}±1.14	6.70^{ab}±1.19	6.68^{ab}±1.18	6.16^{b}±1.20
Color^{NS}	7.32±1.29	6.84±1.08	7.00±1.03	6.59±1.38
Flavor	6.11^{a}±1.02	5.16^{ab}±1.12	5.54^{ab}±1.26	4.84^{b}±1.17
Taste	5.95^{a}±1.03	5.03^{b}±1.26	5.86^{ab}±1.40	4.38^{c}±1.59
Sweetness	5.81^{a}±1.01	5.49^{ab}±1.05	5.24^{ab}±1.02	4.73^{b}±1.15
Oiliness^{NS}	5.84±0.88	5.32±1.08	6.08±1.15	5.65±1.05
Texture (homogeneously)	6.43^{a}±1.04	5.38^{ab}±1.42	5.54^{ab}±1.34	5.05^{b}±1.20
Overall acceptable	**6.32^{a}**±1.37	5.19^{c}±1.04	**6.11^{a}**±1.28	5.68^{b}±1.48

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

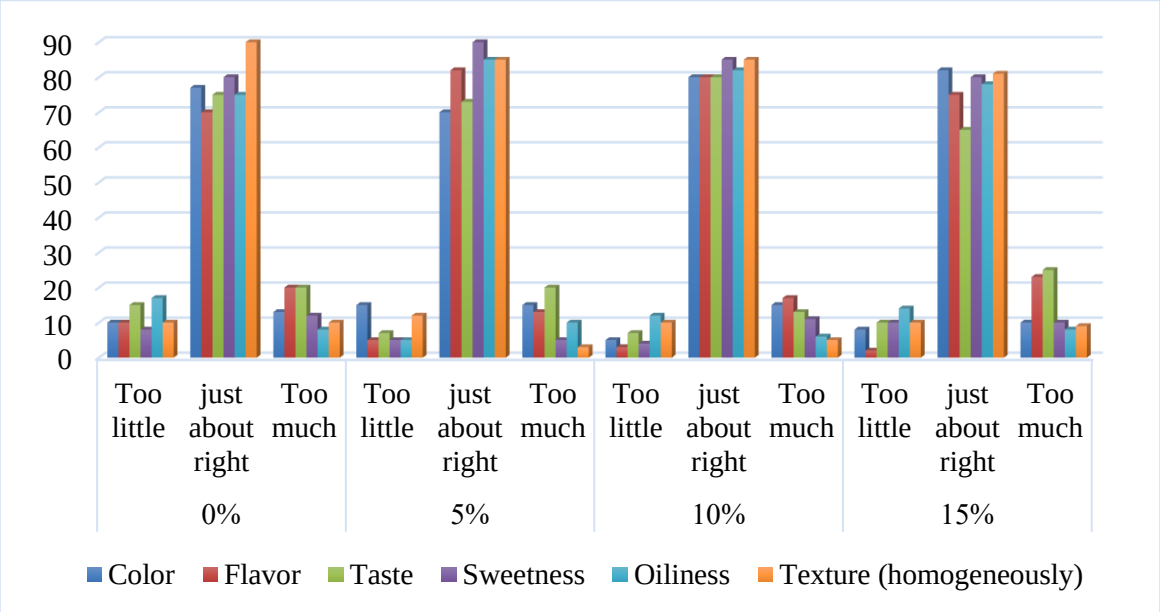

Figure 1: Just About Right of chocolate-cricket gelato with varied cricket powder level

The higher 70% Just About Right (JAR) of chocolate-cricket gelato with all attributes (color, flavor, taste, sweetness, oiliness, and texture (homogeneously) resulted in chocolate-cricket gelato with 10% cricket powder (Figure 1). Hence, this treatment was suitable in developed chocolate-cricket gelato to fit target consumer needs.

3. Investigation the consumer liking and acceptance of developed cricket gelato

The results of the questionnaire with 200 untrained panelist (target consumer) showed that most of the consumer were female (63%), 18-30 years (70%), with a bachelor degree (58%), student (75%), and had 15,000-20,000 THB income (52%).

The sensory attributes in terms of appearance, color, flavor, taste, sweetness, oiliness, texture (homogeneously), and overall liking are measured. This data was used to show consumer likings of developed chocolate-cricket gelato. The sensory attributes in term of liking score show that developed chocolate-cricket gelato had an appearance at 6.45±1.10 (slight liking), color at 7.08±0.80 (moderate liking), flavor at 6.30±1.12 (slight liking), taste at 6.75±1.34 (slight liking), sweetness at 6.82±1.20 (slight liking), oiliness at 7.15±0.87 (moderate liking), texture (homogeneously) at 6.27±0.95 (slight liking) and overall liking at 7.04±1.10 (moderate liking), respectively (Table 4).

Table 4: Consumer liking of developed chocolate-cricket gelato

Attribute	Developed cricket gelato (10% Cricket powder)
Appearance	6.45±1.10
Color	7.08±0.80
Flavor	6.30±1.12
Taste	6.75±1.34
Sweetness	6.82±1.20
Oiliness	7.15±0.87
Texture (homogeneously)	6.27±0.95
Overall acceptable	7.04±1.10

The consumer acceptance of developed cricket gelato was accepted by 90% of the target consumer, and 84% of the purchase intention. For undecided consumer the developed cricket gelato, they suggested providing more information of health benefits and safety cricket from the organic farm as shown in Table 5.

Table 5: Consumer acceptance of developed cricket gelato

Question	Yes (%)	Undecided (%)	No (%)
Product acceptance	90	5	5
Purchase Intention	84	12	4

Conclusion

The appropriate formulation of cricket gelato was chocolate taste with 10% cricket powder. This formulation had high overall acceptable score, high protein content and higher 70% Just About Right (JAR). The chemical property of chocolate-cricket gelato with 10% cricket powder was 50.72% moisture content, 7.87% crude protein, 1.62% ash 14.74% fat, 10.33% fiber and 14.72% carbohydrate. The sensory attributes in terms of liking score show that developed chocolate-cricket gelato have overall liking at 7.04±1.10 (moderate liking). The consumer acceptance of developed cricket gelato was accepted by 90% of the target consumer, and 84% purchase intention. Hence, the developed chocolate-cricket gelato was a product innovation with high protein and lactose-free ingredients to lactose allergy consumers.

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SENSORY EVALUATION OF THREE FORMULAE VEGGIE BURGER PATTIES

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Abstract

This research aimed to study the sensory evaluation and just about right tests of three formulae veggie burger patties with different textured soy protein and rice flour contents in the ratios of 20:0 (formula A), 15:5 (formula B) and 10:10 (formula C). The amount of other ingredients in these three formulae, including five mushrooms, tofu, carrot, black pepper, paprika, mala, salt, sugar, soy sauce and sesame oil, were same. The Duncan's multiple range test of sensory attributes was performed on the experiment by using 50 of the untrained panelists. The product that had the highest preference score was selected and developed for its better attributes according to its just about right score. The overall acceptance and purchase decision were investigated.

The result revealed that most of the respondents was female (65%) aged ranging between 21 to 35 years. The result showed that hedonic score in term of chewiness, juiciness, beany flavor and overall acceptance of formula C was the highest. The lower textured soy protein content (from 20% to 10%) was leading to higher chewiness and juiciness, but lesser beany flavor and brown color. The hedonic score in terms of spiciness of 3-formulae burger patties were not statistically significant different at 0.05 level. From the just about right scaling result, which used to improve product attribute intensity, revealed that formula C should be opted and developed further when compared to formula A and B. After continuously developing formula C, the preference on overall attributes of the improved veggie burger patty (formula D) was liked moderately (7.70 ± 1.63). Ninety-six percent of respondents (48 from 50 panelists) accepted and seventy-four percent of respondents (37 from 50 panelists) made decision to purchase this developed veggie burger patty.

Keywords: Veggie burger patty, Textured soy protein, Mushroom, Sensory Attributes and Just about right scale

Introduction

Burgers are one of the most popular kinds of fast food in the world today. It is categorized as a convenience food, which highly required from many urban areas (Brunner et al., 2010). The intake of burgers in Thailand has increased rapidly over the past few years due to the promotion and online food delivery. Thus, it is not surprising that there is a wide range of research studies in this area whether academic or industry sectors. De Marchi et al. (2021) studied the comparison of the nutritional composition between commercial meat-based burgers and plant-based burgers. Likewise, Schouteten et al. (2016) explored the similarities and differences of emotional and sensory profiling of commercial insect-, plant- and meat-based burgers. For patty formula studies, plant origins or plant-based products have been widely used as a minor ingredient in meat burger patties due to reducing cost and improving functionality. For example, Carvalho et al. (2017) discovered that the incorporation of textured soy protein, collagen, maltodextrin and their combinations in beef burger could improve the cooking properties, texture and sensory acceptance. Angor and Al-abdullah (2010) found that the addition of carrageenan, textured soy protein and trisodium phosphate in beef burger

could develop sensory attributes, protein content and cooking loss. Likewise, Gujral et al., (2002) reported that the combination of liquid whole egg, fat and textured soy protein in goat patty resulted in better texture and cooking properties. In recent years, there are some studies used non-animal sources as a major ingredient. Samard et al., (2021) examined the physicochemical properties of meatless burger patty by using 83% textured vegetable protein. Taylor and Walsh (2002) developed the meatless patty by using textured whey protein, mushroom and corn oil in main proportion.

Therefore, it cannot be denied that the plant sources and plant-based products play a significant role in the burger patty development. Textured soy protein, containing beneficial nutrition such as essential amino acids, low saturated fat and cholesterol-free, has been widely used to replace the meat part in meat patty as it can be mimicked texture like meat muscle, increased moisture retention and decreased patty shrinkage (Asgar et al., 2010; Samard and Ryu, 2019). Rice flour has been frequently used as binder because it can maintain the patty cohesiveness with bland flavor and its ability of holding protein molecules together (Bocevska et al., 2009). Mushrooms are the well-known veggie ingredients, which are suitable substitute for meat due to its taste, savory flavor (umami), texture and nutrient. Mushrooms can contribute moisture that improve the mouth feel and overall sensory appeal with their low energy density (about 92% water) (Feeney et al., 2014). Carrots are inexpensive material and nutrient-dense in vitamins, minerals, fibers and antioxidants. A meaty bite and a caramelized exterior are performed when carrots are baked. Black pepper and paprika are a universal seasoning that use in patty for taste and flavor. Moreover, these seasonings help increase the breakdown and digest fats and proteins. The term of mala or málà is a renowned Chinese seasoning, which is originally from Sichuan province in southwest China with its characteristic in spicy taste and numbing, referring to the feeling in the mouth after eating (Jie et al., 2019). Mala is being popular in Thailand these days. This seasoning is produced from Sichuan peppercorn, dried chili peppers, chili powder, garlic, ginger, salt and sugar. Sesame oil is used for mixing mala and other spices well. Salt has been commonly used to reduce cooking loss and increase solubility and moisture retention (Puolanne and Terrell, 1983), while sugar has been added to complement glutamic acid on burger patty by enhancing the caramelization. Soy sauce is used to help maintain the balance and interaction among different taste components. This research aims to apply all these plant materials, spices and condiments to study and develop the healthy plant-based burger patty without meat by mainly using mushrooms, textured soy protein and rice flour.

Research objectives

1. To study the effect of textured soy protein and rice flour contents of veggie burger patties
2. To study the sensory properties and just about right scale tests of veggie burger patties
3. To study the consumer's acceptance and buying decision of the improved veggie burger patty

Literature review

Veggie Burger Patty

Burger is a convenience food product, which helps consumers reduce time as well as the physical and mental effort required for food preparation, consumption and cleanup (Brunner et al., 2010). Most of the global burger consumption are animal burgers such as beef, pork, chicken, fish, shrimp and lamb burgers. These animal-based burgers consist mainly of proteins and fats and to a lesser extent of seasoning, salt and binders. Moreover, the meat extenders and substitutes are frequently mixed for not only minimizing the cost, but also improving the quality characteristics (Carvalho et al., 2017). Recently, in 2021, the introduction of the 100% plant-based burger has been

offered by global fast food restaurants such as McDonald's, Burger King, KFC, Ikea and Qdoba in order to cater to the growing number of flexitarian or semi-vegetarian who encourages consuming less meat and more plant-based foods. This is including the consumers who want the plant-based burger to taste more like meat and rich in nutrition.

Plant burger or veggie burger is classified as a burger completely made from non-meat ingredients or plant protein sources such as textured vegetable protein, soy flour, wheat flour, wheat gluten, lentil, soybean, tofu, nut, grain, seed, mushroom, carrot, onion, garlic, rice, rice flour and vegetable oil (De Silva et al., 2011; Forghani et al., 2017; Samard et al., 2021; Sherif and El, 2017; Taylor and Walsh, 2002). Thus, it is interesting to develop the healthy plant-based burger patty without animal origin in order to meet the increased demand of target customers.

Methodology

1. Veggie Burger Patty Preparation

Burger patties were made from three different recipes according to The Table 1. The difference between them were the proportion of textured soy protein and rice flour contents in the formula, while the rest of the ingredients were same and constant. Formula A, B and C were produced by mixed textured soy protein with rice flour in the ratios of 20:0, 15:5 and 10:10 (w/w), respectively.

Table 1: Formulation of experimental blends of three veggie burger patties.

Ingredients	Formula (%)		
	A	B	C
Textured soy protein	20	15	10
Rice flour	-	5	10
Firm soybean tofu	8	8	8
Wood ear mushroom	7	7	7
Black shimeji mushroom	10	10	10
White shimeji mushroom	10	10	10
Eryngii mushroom	10	10	10
Grey oyster mushroom	10	10	10
Carrot	5	5	5
Black pepper	1.5	1.5	1.5
Paprika	1.5	1.5	1.5
Mala	4	4	4
Salt	0.5	0.5	0.5
Sugar	4.5	4.5	4.5
Soy sauce	6	6	6
Sesame oil	2	2	2
Total	100	100	100

Three veggie burger patties were prepared as the same procedure. Firstly, the dried textured soy proteins were hydrated with water in the ratio of 1:5 for about 5 min until its soft and puffy. The hydrated samples were then squeezed the water out by hands. Secondly, the five mushrooms, carrots and tofu were cut in the small pieces prior grinding in an electric food chopper. After that, the ground sample was mixed with all spices, salt, sugar, soy sauce and sesame oil until

uniformly blended. Thirdly, the last ingredient, rice flour, was added according to the recipes (B and C) and then kneaded by hands for 3 min. Each paste was weighted 50 g and shaped like a ball. Each ball was formed into a burger press maker and then stored in fridge at 4°C for 30 min. After 30 min of patty formation, the samples were steamed with boiled water for 12 min by using a steamer. Steamed patties then were baked at 170°C for 2 min (1 min per side) and a minimum internal end point temperature of 75°C was reached (Samard et al., 2021). The three baked veggie burger patties were served within 1 minute for sensory analysis. The patty, tomato, lettuce and plain veggie burger buns were served to eat between tasting samples as illustrated in Picture 1.

Picture 1: The sample of veggie burger patty

2. Sensory Evaluation

A 9-point hedonic scale is commonly used to assess the acceptability of food product. The criteria used were: brown color, chewiness, juiciness, spiciness, beany flavor, odor desirability and overall acceptance on a scale of 1 to 9, where 9 represented “like extremely” and 1 represented “dislike extremely.” The 3-scale just about right test is used for measuring attribute intensity and acceptability simultaneously (Carvalho et al., 2017). The attributes are designed as continuous line scale with three descriptive principles, low intensity (much too weak) on the left end, just-about-right or acceptance at the center, and high intensity (much too strong) on the right end, score ranging from 1 to 3, respectively. If the net score is less than -20, the attribute intensity should be increased. On the contrary, if it is higher than 20, the attribute intensity should be decreased. The net score between -20 and 20 means that the attribute intensity is just about right. Besides, the acceptance and the buying decision of the burger patty (100 g. for 60 THB) were asked.

A panel of 50 untrained students and staff aged ranging from 21 to 35 years, Food Business Management Department, Panyapiwat Institute of Management, attended in the sensory evaluation. Every panelist was served three pieces from three different formulae. Samples were blind coded with random three-digit numbers and the order of serving samples was randomized so that each sample occurred equally. One cup of water was served to rinse.

3. Veggie Burger Patty Development

The veggie burger patty with ratio of 10:10 textured soy protein to rice flour (formula C) was chosen for the further development of burger patty. The paprika and mala contents in the formula were reduced from 1.5% to 0.5% and 4% to 2%, respectively. Moreover, the baking time in the oven was increased from 2 min to 5 min. The preference, acceptance and purchasing intention were proceeded to 50 target panelists (same group as mentioned above). The preference test was evaluated the attributes in the same terms of brown color, chewiness, juiciness, spiciness, beany flavor, odor and overall acceptance using the 9-point hedonic scale.

Statistical analysis

Burger patty data: percentage, mean and standard deviation were analyzed by using IBM SPSS software version 24.0 (IBM, Armonk, NY, USA). Significant differences among treatments were determined at $p<0.05$ using Duncan's multiple range test.

Results and discussion

The result indicated that the respondents who participated in the sensory evaluation of this research were female 65% and male 35%, aged ranging from 21 to 35 years. The sensory attributes of 3-formulae veggie burger patties were significantly ($P<0.05$) dependent on textured soy protein and rice flour contents in the formulation as indicated in Table 2. The highest overall acceptance score was formula C (6.83 ± 1.50), while the lowest score was formula A (5.07 ± 1.15). The decreasing of textured soy protein content from 20% to 10% was leading to the higher scores of chewiness, juiciness, beany flavor and overall acceptance ($p<0.05$). Moreover, the hedonic score in term of brown color of 3-formulae veggie burger patties tended to decrease when decreasing textured soy protein content. Only spiciness score showed no statistically significant differences at 0.05 level among three formulae.

Table 2: Sensory attributes of veggie burger patties

Attributes	Formula		
	A	B	C
Brown color	6.50 ± 1.00^{a}	6.47 ± 1.57^{a}	6.20 ± 1.00^{b}
Chewiness	5.47 ± 0.97^{c}	5.67 ± 0.98^{b}	6.77 ± 1.00^{a}
Juiciness	4.57 ± 0.97^{c}	5.43 ± 1.12^{b}	7.03 ± 1.15^{a}
Spiciness	5.27 ± 1.52^{ns}	5.43 ± 1.52^{ns}	5.37 ± 1.62^{ns}
Beany flavor	4.47 ± 1.52^{c}	5.27 ± 0.97^{b}	6.23 ± 0.87^{a}
Odor	4.90 ± 1.00^{b}	5.30 ± 1.00^{a}	5.40 ± 1.00^{a}
Overall acceptance	5.07 ± 1.15^{c}	6.20 ± 1.23^{b}	6.83 ± 1.50^{a}

Values are means ± standard deviation
Different letters (a–c) in the same row are significantly different at $p<0.05$

The just about right score of formula-C veggie burger patty showed the different consideration, compared to formula A and B as displayed in Table 3. The brown color and chewiness intensity of both formula A and B were too low and should be increased, whereas the other attributes including juiciness, spiciness, odor and beany flavor of both formulae were too high and should be decreased. This might be due to these patties were easily breaking apart and were not stick together well, especially formula A. In addition, the texture of these patties was too soft and mushy. It might be explained that the lower textured soy protein content and higher rice flour content lead to the stronger patty. The viscosity of rice flour was related to the gelatinization of starch granules and the ability of holding protein molecules together (Bocevska et al., 2009). After baking, rice flour provided a hard firm consistency gel and maintained the patty cohesiveness. The beany flavor of sample decreased with the decreasing of textured soy protein content from 20% to 10% as the result showed that respondents preferred formula C to formula A. Joshi and Kumar (2015) described that textured soy protein provided the strong off-flavors (including grassy and beany flavor due to activity of lipoxygenases) and the other bitter and astringent flavors (due to saponins and isoflavones).

For formula C, the results of chewiness, juiciness and odor intensity were just about right and be considered not to be improved. However, the intensity of brown color, spiciness and beany flavor of formula C needed to be developed as same as the formula A and B. The result of just about right scale was in accordance to the 9-hedonic scale that respondents preferred sensory attributes of formula C to those of formula A and B except color attribute.

Table 3: Just-about-right (JAR) consideration of veggie burger patties

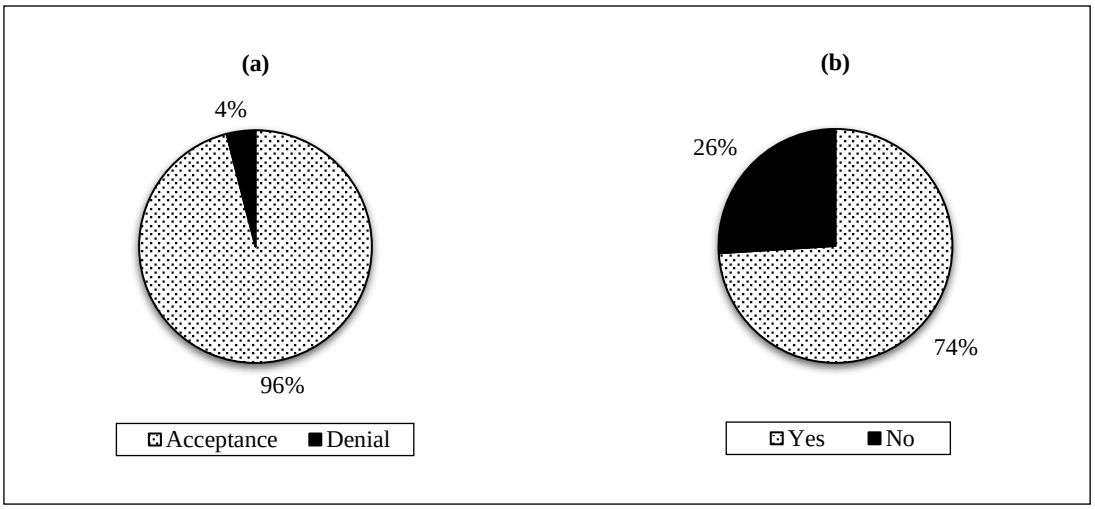
Formula	Attributes	Intensity (%)			Net score	Consideration
		Too weak	JAR	Too strong		
A	Brown color	34	63	3	-31	Increase
	Chewiness	48	52	0	-48	Increase
	Juiciness	0	45	55	55	Decrease
	Spiciness	0	56	44	44	Decrease
	Odor	0	64	36	36	Decrease
	Beany flavor	7	51	42	35	Decrease
B	Brown color	35	65	0	-35	Increase
	Chewiness	40	60	0	-40	Increase
	Juiciness	0	52	48	48	Decrease
	Spiciness	0	54	46	46	Decrease
	Odor	0	62	38	38	Decrease
	Beany flavor	4	58	38	34	Decrease
C	Brown color	36	64	0	-36	Increase
	Chewiness	15	75	10	-5	JAR
	Juiciness	15	70	15	0	JAR
	Spiciness	0	58	42	42	Decrease
	Odor	13	67	20	7	JAR
	Beany flavor	10	57	33	23	Decrease

The veggie burger patty formulated by 10% textured soy protein and 10% rice flour (formula C) was chosen in order to develop product further. The paprika and mala contents in the formula were reduced from 1.5% to 0.5% and 4% to 2%, respectively. The intensity of brown color of the sample was increased by increasing more baking time from 2 min to 5 min. The sensory attributes of the improved veggie burger patty are presented in Table 4. The overall acceptance score revealed that respondents liked this burger patty moderately (7.70 ± 1.63). Ninety-six percent of respondents (48 panelists) accepted and seventy-four percent (37 panelists) decided to purchase this improved veggie burger patty at 30 THB per 50 g (Picture 2). On the other side, few panelists about four percent did not accept this product by reasoning of beany flavor, spiciness and taste of Mala. They mentioned that the product needed to further developed and improved. Almost a quarter of respondents (26% respondents) considered not to purchase this product because of the high price. Some of the respondents discussed that this cost (30 THB) was more expensive than commercial meat burger patty.

Table 4: Quality attributes of improved veggie burger patties

Attributes	Score
Brown color	8.20 ± 1.50
Chewiness	7.30 ± 1.54
Juiciness	8.00 ± 1.30
Spiciness	7.00 ± 1.40
Beany flavor	6.50 ± 1.32
Odor	6.80 ± 1.56
Overall acceptance	7.70 ± 1.63

Values are means (N=50) ± standard deviation



Picture 2: The acceptance (a) and the buying decision (b) of improved veggie burger patties

Conclusions

The comparison of 3-formulae veggie burger patties produced with different textured soy protein and rice flour contents revealed that the lower amount of textured soy protein content, the higher preference score of chewiness, juiciness, beany flavor and odor of burger patty. The formula C was highest chewiness, juiciness, beany flavor and overall acceptance. The respondents liked the developed veggie burger patty moderately. Ninety-six percent of respondents (48 from 50 panelists) accepted the product and three quarters of respondents (37 from 50 panelists) decided to purchase this developed veggie burger patty at 30 THB per 50g.

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