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Product development of fruit tea mixed with "Hed Krang" (*Schizophyllum commune*)

Mongkontanawat, N. *

Department of Product development and Management Technology, Faculty of Agro-Industrial Technology, Rajamangala University of Technology Tawan-ok, Chanthaburi campus, Chanthaburi, 22210 Thailand

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Fruit teas are composed of vitamins, minerals, anti-oxidants and many phyto-nutrients that good for heath. Hed Krang (*Schizophyllum commune*) also contain interesting functional component, especially β-glucan. This compound has been shown powerful medicinal properties. From this point, the local fruit tea product development added with Hed Krang have been performed in order to increase health benefits. Three kinds of local fruit; pineapple (*Ananas comosus*), salak (*Salacca zalacca*), longan (*Dimocarpus longan* Lour.) and Hed Krang were dried by using hot air oven and grinding by using the blender. Fruit tea development was evaluated by using mixture design. Then, the best ratio was supplemented with Hed Krang powder at the concentration 0, 10, 20 and 30 % (w/w), respectively. Finally, the sensory evaluation and chemical properties, physical properties and microbiological properties were evaluated. Result of this study showed that the optimum formula of fruit tea consisted of the ratio of pineapple, salak and longan 20:20:60, respectively, added with 20 % (w/w) of Hed Krang. The final product was orange-yellowish. The L*, a* and b* value was 37.60, 3.40, and 13.04, respectively. Chemical properties were shown total soluble solid, pH, moisture content and water activity at 7.40 °Brix, 4.62, 4.33 (% wb) and 0.54, respectively. The overall linking of fruit tea was rated as like moderately (6.60). The total microorganism, yeast and molds were found at 3.80 x 10^4 and 2.00 x 10^3 CFU/g, respectively. From the results of consumer testing, most of consumer(54%) was also rated as like moderately (6.90). After knowing about the benefits of this product, the percentage of acceptance and purchasing were increased to 89 % and 89 %, respectively. Most consumers (58 %) accepted the price at 65 baht/package. In conclusion, the new tea product could be the advertent powerful for health and consumer also high acceptable.

Keywords: fruit tea, local fruit, *Schizophyllum commune* , β-glucan

Introduction

Nowaday, many people suffer in health problem such as over nutrition, lower nutrition and many discases. Therefore, most of food scientist try to find

* Corresponding author: Mongkontanawat, N., Email: jeabn2009@gmail.com

the good food in order to prevent discases. Recent studied, fruit and vegetable are the good diet which constitute an important component in human nutrition.

They are medicines compacted with vitamins, minerals, anti-oxidants and many phyto-nutrients (Feskanich *et al*., 2000). In addition, their color and flavor are good that help the human body free of diseases and stay healthy. Fruits are low in calories and fat and are a source of simple sugars, fiber, and vitamins, which are essential for optimizing our health. Also, fruits are provide soluble dietary fiber, which helps to eliminate of cholesterol and fats from the body to get a good heath (Kraus, 2013). From the nutional point of view, the local fruit in this area have been used in this study. There are pineapple (*Ananas comosus*), salak (*Salacca zalacca*) and longan (*Dimocarpus longan* Lour.). Pineapple (*Ananas comosus*) is a tropical and subtropical fruit (Chan *et al*., 2003). The consumer is widely appreciated for its tast, flavor and nutrient content (Uckianh *et al*., 2009). Salak (*Salacca zalacca*) is a species of palm tree native to Malaysia and Indonesia (Aralas *et al*., 2009). It is grown extensively in South-East Asia. The fruit is also known as "snake fruit" (Shela *et al.*, 2009).

It is a good food source due to its high value of dietary fiber and carbohydrate fraction (Lestari *et al*., 2003). Additionally, it contains valuable bioactive antioxidant such as pro-vitamin A, vitamin C and phenolic compounds (Setiawan *et al*., 2001; Leong and Shui, 2002; Leontowicsz *et al.*, 2006; Aralas *et al*., 2009). Longan (*Dimocarpus longan* Lour.) is an evergreen tree of the *Sapindaceae* family. It is widely grown in Southern China, India, and Southeast Asia (Jiang *et al*., 2002). An important nutrition of fruits as mention above is rich in vitamin C content low fat and choresterol (U.S. Food and Drug Administration, 2008). Vitamin C which are antioxidant, reduces nitrite by reducing formation of nitrosamines (Block, 1991; Byers and Querrero, 1995; Duyn, 2000). In additional, this component of the diet has many functions in the body such as enhancing the absorption of iron, synthesis of collagen and bones, formation of antibodies and many others (Uckianh *et al.*, 2009). In fact, In most part of Asia, particularly Thailand, our country are cultivated many kinds of fruit. In the local research area, chanthaburi provine, perfect of fruits are exhibit and the gardener face a problem production oversupply every year. So, food processing and product development could be help to solve this problem.

Also mushroom have been used as medicinal food in Asian region for long time ago especially in Japan, Chinal and Korea (Manzi and Pizzoferrato, 2000). Previously researchs reported that mushrooms have been an important source of novel bioactive compounds (Hawksworth, 1991). It also have great potential as a nutritionally functional food and a source of physiologically

beneficial and non-toxic medicines (Wasser and Weis, 1999). Moreover, many other researchers supported the idea that mushrooms have become attractive as a functional food and as a source for the development of drugs and nutraceuticals. As for their nutritional value, the edible mushrooms have been reported to below in calories and in fat but rich in proteins, minerals and dietary fibre. Mushrooms also contain significanty amounts of vitamins, that is thiamin, riboflavin, ascorbic acid and vitamin D2, as well as minerals (Breene, 1990; Miles and Chang, 1997). They are also a potential source of interesting functional components dietary fibre, β-glucans. β-Glucans are group of polysaccharides that are composed of glucose units linked together with β-glycosidic bonds (Klis *et al*., 2002). β-Glucans also exhibit medicinal properties such as antitumor, antimicrobial and antioxidant activities plus mycotoxin absorption (Manzi and Pizzoferrato, 2000; Chen and Seviour, 2007) as well as uses in stimulation of the immune response in animals and the reduction of blood cholesterol and glucose levels (Nicolosi *et al*., 1999). In addition, Manzi *et al.* (1999), described that mushrooms are much more for their texture and flavor. Recent researches reported that medicinal mushrooms has been shown medicinal properties. For example, they are reported various immunological and anti-cancer properties. They also offer other potentially important therapeutic properties including antioxidants, anti-hypertensive, cholesterol-lowering, liver protection, anti-fibrotic, anti-inflammatory, anti-diabetic, anti-tumor, anti-viral, antimicrobial other beneficial or therapeutic health effects without any significant toxicity (Breene, 1990; Miles and Chang, 1997; Wasser and Weis, 1999; Salahuddin, 2008). Asian countries are known to be rich source of medicinal mushrooms. Especially Thailand also founded and cultivated various mushrooms. *S. commune* has long been acknowledged for its medicinal properties and cultivated in many part of Thailand. In addition, *S. commune* has been consumed as a nutritional food in South-East Asia (Han *et al*., 2005). The production of *S. commune* has increased due to the ease of cultivation, increase in popularity and its nutritional value (Chang and Buswell, 1996; Wasser *et al*., 2003). Furthermore, They are very important because it produces the polysaccharide schizophyllan (interesting dietary fibre) which shows considerable medicinal properties. Moreover, no studied on product development of fruit tea mixed with this medicinal mushroom has been reported. For this reason, *s. commune* was selected to be studied. Therefore, the objective of this study were to studied on ratio of optimum three kinds of local fruit; pineapple, salak and longan for fruit tea production. Then the best treatment was selected for studied on the optimum quantity of Hed Krang of fruit tea production. Finally, the final product was to consumer surway acceptation.

Materials and methods

Pineapple, salak, longan were all purchased from a local market at Krating market in Amphur Kao Kitchakut. Hed Krang was purchased from a local farm and transported to the laboratory.

Sample Preparation

Three kinds of local fruit as mention above were peeled with a stainless steel knife, washed and sliced in the small size (1 cm^3), respectively. Hed krang was soaked with distilled water. Then, all of sample were dried by using hot air oven (Binder, FD115, Germany) at 70 $^{\circ}$C for 24 hours. The dry samples were grinding by using blender.

Product development of fruit tea

The first section, studied on ratio of optimum quantity of three kinds of fruit for fruit tea production by using mixture design. Seven treatments were shown as table 1.

Table 1. Seven treatments of fruit tea production by using mixture design

Treatments	**The three kinds of fruit**		
	Pineapple	Salak	Longan
1	60	20	20
2	40	40	20
3	20	60	20
4	20	40	40
5	20	20	60
6	40	20	40
7	33.3	33.3	33.3

Then the best treatment was selected for studied on the optimum amount of Hed Krang for fruit tea production. Four treatments of various concentrations of Hed Krang at 0, 10, 20 and 30 % (w/w), respectively were done by using Randomized Complete Block Design (RCBD). Then the physical, chemical properties of fruit tea were determined as describe belows.

Physical properties determination

Fruit tea was soaked in hot water for the ratio of fruit tea : hot water 1:10. Next, measurements of the fruit tea solution colure were conducted using a

Color meter (Nippon Denshoku, ZE-2000, Japan). The equipment was calibrated with standard plate. Colour measurement were expressed in L* indicates the lightness on a 0 to 100 scale from black to write. a* (+,-) are indicates the redness or greeness,respectively. b* (+,-) are indicates yellowness and buleness, respectively.

Chemical properties determination

The fruit tea solution was prepared as described above. Then, The total soluble solid was determined by using hand refractometer(Atago, Japan), pH by using pH-meter (Subtex, Taiwan). The fruit tea powder was measured moisture content by using Moisture meters (Sartorius, MA45Q, Germany) and water activity (a_w) by using Pa_wkit water activity meter (Decagon, N/A 2000, USA.)

Microbiological properties determination

The final product was examined total microorganism , mold and yeast by using total plate count on Plate Count Agar (PCA) and Potato Dextrose Agar (PDA), respectively.

Sensory evalution

Fruit tea was soaked in hot water for the ratio of fruit tea : hot water 1:10. Then the fruit tea solution was sensory evalution with 50 untrained panelists from the staff and students of Department of Product development and Management Technology, Rajamangala University of Technology Tawan-ok, Chanthaburi campus. They evaluated the sample using a nine point hedonic scals ranging from 1(extremely disliked) to 9(extremely liked) (Watts *et al*., 1989). Each panelist evaluated the samples for color, flavor, taste and overall acceptability.

Consumer testing

The highest overall acceptability treatment was prepared as described above and determined for final consumer acceptation with 100 untrained panelist by CLT (Central Location Test) (Boutrolle *et al*., 2007).

Data analysis

Properties analysis were carried out in three replicates. The data were subjected to Analysis of Variance (ANOVA) ($p \leq 0.05$) (Steel *et al*., 1997). Mean with significant differences were separated by Duncan's Multiple Range Test (DMRT) using computer software .

Results and discussions

Sensory evaluation of fruit tea: Table 2 presents the sensory score associate with fruit tea made from the various ratio of pineapple, salak and longan by using mixture design as mention above. The mean sensory scores of 7 treatments differed significantly ($p \leq 0.05$) in colour, aroma, taste and acceptability. The colour, aroma, taste and general acceptability all ranged between nearly like slightly and like moderately. Treatment 5 (the ratio of pineapple, salak and longan; 20:20:60) was most generally accepted among the samples and significantly different ($p \leq 0.05$) from other treatments. This could be because this treatment was exhibited yellowish brown colour, odorous of longan flavor, moderately sweet. From this condition could be accurate the needs of consumers. Then all treatments were determined of physical and chemical properties as shown in Table 3.

Table 2. Mean sensory scores of fruit tea

Treatments	Parameter			
	Colour	Aroma	Taste	Acceptability
1	5.96^{cd}	5.74^{c}	5.48^{d}	5.76^{d}
2	5.88^{d}	5.90^{c}	5.62^{d}	5.88^{d}
3	5.80^{d}	5.78^{c}	5.80^{d}	5.98^{d}
4	6.30^{c}	6.62^{ab}	6.92^{b}	6.92^{b}
5	7.82^{a}	6.94^{a}	7.38^{a}	7.46^{a}
6	7.08^{b}	6.46^{b}	6.32^{c}	6.36^{c}
7	7.04^{b}	6.98^{a}	7.00^{b}	7.08^{b}

Mean with different letters are statistically different ($p \leq 0.05$) according to Duncan's Multiple Range test.

Physical properties of fruit tea: The results of the physical and chemical properties of fruit tea are shown in Table 3. The level of L*(lightness), a*(redness/greeness) and b* (yellowness/buleness) were found to vary between 16.02± 0.32 – 20.70±0.09, 0.11± 0.05 – 2.08±0.28 and 4.63±0.12 – 7.58±0.22 for all treatments, respectively. Treatment 3 (the ratio of pineapple, salak and longan; 20:60:20) was found highest level of L* and b*; 20.07±0.09 and 7.58± 0.22, respectively and significantly different ($p \leq 0.05$) from other treatments. From this results could be propose that substitution of salak

increased the level of L* (lightness) and b* (yellowness). However, For the level of a*, the highest level was exhibited in treatment 5 (the ratio of pineapple, salak and longan; 20:20:60). This could be explained that generally longan is sweet and higher sugar content than other (US. Food and Drug Administration,2008). So, after drying reaction it could be dark browning reaction, dark colour and redness could be found in this study.

Table 3. Physical and chemical properties of fruit tea

Treatments Physical properties	**1**	**2**	**3**	**4**	**5**	**6**	**7**
L*	16.36 ± 0.52 ^{de}	16.75± 0.38 ^{cd}	20.70± 0.09^{a}	17.81±0.08 ^{b}	16.52± 0.07^{de}	16.02±0.32 ^{e}	17.23± 0.55^{bc}
a*	0.71± 0.13^{d}	0.11± 0.05^{e}	0.71± 0.06^{d}	1.27± 0.10^{c}	2.08 ± 0.28^{a}	1.86± 0.10^{a}	1.59± 0.14 ^{b}
b*	5.29± 0.15^{d}	4.63± 0.12^{e}	7.58 ±0.22 ^{a}	6.51± 0.26^{b}	6.04± 0.05^{c}	5.96 ± 0.10^{c}	6.46± 0.18^{b}
Chemical properties							
Total soluble solid ($^{\circ}$Brix)	6.20± 0.01^{d}	6.20± 0.00^{d}	6.10± 0.01^{e}	7.00± 0.00^{b}	7.00± 0.00^{b}	7.10± 0.00^{a}	6.90± 0.01^{c}
pH	3.87± 0.01^{d}	3.77± 0.01^{f}	3.72± 0.01^{g}	3.95± 0.01^{b}	4.10± 0.01^{a}	3.94± 0.01^{c}	3.80± 0.01^{e}
moisture content (% wb)	4.78± 0.18^{a}	4.37± 0.19^{b}	4.70±0.11 ^{a}	4.27± 0.14^{b}	4.34± 0.07^{b}	4.42± 0.02^{b}	4.24±0.03 ^{b}
water activity	0.48± 0.03^{d}	0.53± 0.04^{bc}	0.57± 0.01^{a}	0.53± 0.01^{bc}	0.52± 0.02^{bcd}	0.53± 0.01^{bc}	0.49± 0.02^{cd}

L* (lightness) 0 = black, 100 = white
a*(redness/greeness) + = redness, - = greeness
b*(yellowness/buleness) + = yellowness, - = buleness
Each data represents mean of three replications with standard errer.
Mean with different letters are statistically different ($p \leq 0.05$) according to Duncan's Multiple Range test.

Chemical properties of fruit tea: the level of soluble solid, pH, moisture content and water activity (a_w) were to vary between 6.10± 0.01 - 7.10± 0.00 $^{\circ}$Brix, 3.72± 0.01- 4.10± 0.01, 4.24±0.03 - 4.78± 0.18 % and 0.48± 0.03- 0.57± 0.01 for all treatments, respectively. Form our results propose that all treatments are high acidity, low moisture content which indicated that our product can be stored for a longer period. Treatment 5 (the ratio of pineapple, salak and longan: 20:20:60) was shown highest pH (4.10± 0.01) and also high total soluble solid 7.00± 0.00 $^{\circ}$Brix. This could be explained that generally longan is sweet and more sugar content , thus the increasing of substitution of longan should be increase the two parameters. In contrast, the increasing of substitution of salak was found high the moisture content (4.70±0.11) and water

activity (0.57± 0.01). This results could be because generally structure of three kinds of fruit are differences, so after drying method the moisture content were slightly differences.

Sensory evaluation of fruit tea mixed with Hed Krang: Table 4 presents the sensory score associate with fruit tea supplemented with Hed Krang at concentration at 0, 10, 20 and 30 % (w/w), respectively. The mean sensory scores of 4 treatments differed significantly ($p \leq 0.05$) in aroma and acceptability. For the colour and taste were not significantly different ($p \leq 0.05$). The colour, aroma, taste and general acceptability all ranged between like slightly and like moderately. Most generally accepted among the samples was treatment 2 (Hed Krang 10%) but not significantly different ($p \leq 0.05$) from control (treatment 1) and treatment 3 (Hed Krang 20%(w/w)). This results could be because the non-familiarity in aroma of Hed Krang. However, based on the high nutritional value of mushroom, treatment 3 (Hed Krang 20%(w/w)) should be selected for next section for the fruit tea production. Then all treatments were determined of physical and chemical properties as shown in Table 5.

Table 4. Mean sensory scores of fruit tea mixed with Hed Krang

Treatments	**Hed Krang**	**Parameter**			
	(% w/w)	Colour^{ns}	Aroma	Taste^{ns}	Acceptability
1	0	6.82	6.50^{ab}	6.40	6.58^{ab}
2	10	7.00	6.64^{a}	6.56	6.88^{a}
3	20	6.90	6.46^{ab}	6.48	6.60^{ab}
4	30	6.84	6.24^{b}	6.42	6.48^{b}

Mean with different letters are statistically different ($p \leq 0.05$) according to Duncan's Multiple Range test.

Physical properties of fruit tea mixed with Hed Krang : The results of the physical and chemical properties of fruit tea mixed with Hed Krang are shown in Table 5. the level of L*(lightness), a*(redness/greeness) and b*(yellowness/buleness) were found to vary between 13.30± 0.03–16.05±0.06, 1.91±0.16 – 2.79±0.12 and 5.11±0.14 - 6.20±0.24 for all treatments, respectively. The increasing of concentration of Hed Krang was slightly increased a*(redness) and b* (yellowness) but gradually decreased the level of L*(lightness). From this results could be explained that the colour of Hed Krang is brown, so the increasing of mushroom substitution could be reduced lightness, increased redness and yellowness.

Chemical properties of fruit tea mixed with Hed Krang: the level of soluble solid, pH, moisture content and water activity (a_w) were to vary

between 7.03±0.06 - 7.53±0.06 °Brix, 4.36±0.01 - 4.81±0.01, 4.26±0.08 - 4.42±0.05 (% wb) and 0.52±0.01- 0.57±0.02 for all treatments, respectively. Form our results propose that all treatments are also high acidity, low moisture content which indicated that our product can be stored for a longer period. The increasing of concentration of Hed Krang was slightly increased the level of soluble solid and pH but gradually decreased the level of moisture content and water activity (a_w). From this results could be explained that the the composition of Hed Krang are composed of polysaccharide, protein vitamin and mineral (Wasser, 2008). So, the increasing of mushroom substitution could be increase the level of sugar. Interestingly, the increasing of substitution of Hed Krang was slightly decreased the level of moisture content and water activity.

Table 5. Physical and chemical properties of fruit tea mixed with Hed Krang

Treatments	**1**	**2**	**3**	**4**
Physical properties				
L*	16.05±0.06^{a}	14.99±0.06^{b}	13.30±0.43^{c}	13.30± 0.03^{c}
a*	1.91±0.16^{b}	2.17± 0.15^{b}	2.77±0.32^{a}	2.79 ±0.12^{a}
b*	5.86±0.26^{ab}	5.11±0.14^{c}	5.45±0.36^{bc}	6.20±0.24^{a}
Chemical properties				
Total soluble solid (°Brix)	7.03±0.06^{c}	7.33±0.06^{b}	7.40±0.00^{b}	7.53±0.06^{a}
pH	4.36±0.01^{d}	4.52±0.01^{c}	4.62±0.01^{b}	4.81±0.01^{a}
moisture content (% wb)	4.42±0.05^{a}	4.39±0.04^{a}	4.33±0.02^{ab}	4.26±0.08^{b}
water activity	0.57±0.02^{a}	0.55±0.01^{b}	0.54±0.01^{bc}	0.52±0.01^{c}

Each data represents mean of three replications with standard errer.
Mean with different letters are statistically different ($p \leq 0.05$) according to Duncan's Multiple Range test.

From the consumer testing by Central Location Test (CLT), the results were found that most of consumer (54%) was also rated as like moderately (6.90). After knowing about the benefits of this product, the percentage of acceptance were increased to 89 %. However, a few customer (11 %) still agreement the same valuable with other product. Additionally, Most of customer were purchasing the new product up to 89 %. Most consumers (58 %) accepted the price at 65 baht/package. Thirty seven and five percent of customer consented the price at 70 and 75 baht/package, respectively.

Conclusion

The results obtained showed that the optimum ratio of pineapple: salak and longan for fruit tea was production were 20:20:60. Hed Krang 20 % (w/w) was the high acceptable from the sensory evalution. Physical, chemical and microbiological properties of final product were found that the L*, a* and b* value were 37.60, 3.40, and 13.04, respectively. Fruit tea was orange-yellowish. Chemical properties were shown total soluble solid, pH, moisture content and water activity at 7.40 °Brix, 4.62, 4.33 (% wb) and 0.54, respectively. The overall linking of fruit tea was rated as like moderately (6.60). The total microorganism, yeast and molds were found at 3.80×10^4 and 2.00×10^3 CFU/g, respectively. From the results of consumer testing, most of consumer (54%) was also rated as like moderately (6.90). After knowing about the benefits of this product, the percentage of acceptance and purchasing were increased (89 % and 89 %, respectively). Most consumers (58 %) accepted the price at 65 baht/package. In conclusion, this research is good preliminary study on the new tea product development. However, β-glucans content determination could be require to for confirm the higher nutrition value the final product. Moreover, suitable condition for making tea to get the highest amount of β-glucans should be measuring in the further research

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