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EFFECT OF DRYING AND FRYING ON QUALITY OF LIANG VEGETABLE

Vilailak Klompong
Food Science and Technology Department, Thaksin University, Phattalung, Thailand
klompong@hotmail.com

Naruemon Bupphakit
Food Science and Technology Department, Thaksin University, Phattalung, Thailand
naruemongob@hotmail.com

Siriyakorn Chumdang
Food Science and Technology Department, Thaksin University, Phattalung, Thailand
siriyakorn013@gmail.com

Abstract

Liang vegetable (Gnetumgnemon) is originated in the Malay Peninsula and become the local southern vegetable of Thailand. Liang vegetables possess high nutritional value and bioactive compounds associated with antioxidant effects. This research aims to develop crispy Liang vegetable products as a functional snack food with antioxidant activity by studying drying and frying conditions suitable for the product and also analyzing the quality of the finished product. After study on the effect of maturity of leaves on the rank smell by categorizing Liang vegetables into 3 types by color, including old leaves (L^* = 110.26, a^* = -10.90, b^* = 27.66), medium leaves (L^* = 115.26, a^* = -5.93, b^* = 36.33). Young leaves (L^* = 115.36, a^* = 3.36, b^* = 35.10), the result showed that the medium leaves got the highest score of smell preference, followed by old leaves and young leaves ($p<0.05$) respectively. Thereafter, a study on the effect of drying temperature on sensory quality was conducted. The result exhibited that at 70 ºC the product obtained got the highest hedonic scores in terms of texture, color, smell, and overall *liking ($p<0.05$). In addition, the frying temperature at 60ºC was appropriated for producing crispy Liang vegetables, when the sensory evaluation including texture, color, smell, crispness, and overall liking was tested ($p<0.05$). The hardness of the finished product was 301.79 g when measuring with a texture analyzer. Aw and yeasts and mold of the finished product were 0.47 and 2.2 cfu/g, respectively. The crispy Liang vegetable product also possessed antioxidant activity (DPPH radical scavenging activity, 55.06%). Therefore, the quality of crispy Liang vegetable was designated by drying and frying conditions. Additionally, the crispy Liang vegetable possessed antioxidant activity and conformed to the safety of Thailand community product standards. Thus, crispy Liang vegetable products could be served as functional vegetable-based snacks with antioxidant activity for consumer compliance.*

Keywords

Drying, Frying, Quality, Crispy, Liang Vegetable

1. Introduction

Liang vegetable (Gnetumgnemom) is a wild plant originated in Asia, the Malay Peninsula, and found in Thailand, Malaysia and Borneo. G.gnemomvar. Tenerum is normally found throughout the foothills and plains in the southern part of Thailand. Classified as a local vegetable in the southern region of Thailand, Liang vegetable becomes more popular for consuming by commonly using young leaves for cooking and then propagated and planted as economic crops. Additionally, Liang vegetables could be used as herbal medicine, antioxidant, anti-aging, and anticancer since they possess high nutritional value, minerals, vitamin, and bioactive compounds. Bioactive compounds associate with human health (Mondal et al., 2019) because of the antioxidant effect. The strong antioxidant effect can protect cells from damage caused by oxidative stress (Maric et al., 2020) and give potent protective eff ects against diseases (Maseko et al., 2019). Fried products are also consumed worldwide with popularity, correlated with unique taste and odor (Chiou et al., 2012). Fried vegetable contains oil-derived health-promoting micro-constituents such as vitamin E, phytosterols, polyphenols, squalene, triterpenes, and carotenoids since frying oil is absorbed by food and becomes part of the diet during frying. The number of bioactive compounds in the fried vegetable is also influenced by oil type, oil quality, and the frying process (Chiou et al., 2012). The objective of this study was to develop the new fried product from Liang vegetables and investigate for the effect of drying and frying conditions on the quality of crispy Liang vegetables to produce functional food with antioxidant activity in form of snack product for consumer convenience. The quality of the product also needs to meet Thailand's community product standards for food safety.

2. Methodology

2.1 Raw Material

Liang vegetable was purchased from Pho Wai Market, Surat Thani Province, Thailand. The vegetable was packed with a plastic bag, tied up and stored at 4 °C not more than 2 weeks before the experiment.

2.2 Sample Preparation

The leaves are divided into 3 groups according to the age of leaves, which are old, the medium and young leaves, then the color was measured by the color meter (Hunter lab).

2.3 Study on the Effect of Maturity of Leaves on the Rank Odor of Liang Vegetable

Three groups of Liang vegetables were mashed and mixed with ingredients and mold to forming sheets and then dried and fried before sensory evaluation to study on the effects of the maturity of Liang leaves on rank odor. Hedonic scale by 30 panelists was performed to select the suitable age of Liang vegetable for the next step, drying.

2.4 Study on the Optimum Conditions for Drying

The samples were dried using a tray dryer at 60, 70, and 80 °C for 8 hours. The sensory test was performed using a hedonic scale by 30 panelists to select the suitable drying temperature for the next step, frying.

2.5 Study on the Optimum Conditions for Fried Vegetables

By using a frying temperature of at 60, 70, and 80 °C, fried samples were sensory evaluated using a hedonic scale by 30 panelists to select the optimum frying temperature for the finished product.

2.6 Measuring the Quality of Crispy Liang Vegetables

Crispy Liang vegetable was analyzed for hardness using a texture analyzer and measured for water activity (aw). Samples also subjected to color measurement using the color meter for lightness (L*), redness (a*), and yellowness (b*) and yeast and mold count.

2.7 Sensory Evaluation

A sensory evaluation was conducted by 30 panels. Sensory attributes including color, odor, smell, taste, and overall linking were subjected to the 9-point hedonic scale testing, including like extremely (9), like very much (8), like moderately (7), like slightly (6), neither like nor dislike (5), dislike slightly (4), dislike moderately (3), dislike very much (2) and dislike extremely (1). Sensory evaluation was conducted in a room with a uniform source of light, absence of noise, and disturbance at 20°C. Samples were served using a white plate and drinking water was also provided for cleansing their palate between testing.

2.8 Antioxidant Analysis using DPPH Assay

2,2-Diphenyl-1-picryhydrazyl (DPPH) radical-scavenging activity was determined using the method of Yen and Wu (1999). Samples were dissolved in distilled water to get a concentration of 40 mg /ml. To 4 ml of sample solutions, 1.0 ml of 0.2 mM DPPH was filled and mixed. After incubating for 30 min, the absorbance of the obtaining solutions was measured at 517 nm by a spectrophotometer. The control was prepared in the same way, except that distilled water was added instead of the sample. DPPH radical scavenging activity was calculated according to the following equation:

DPPH radical-scavenging activity (%) = (1-(A517 of sample/ A517 of control)) x 100

2.9 Statistical Analysis

One-way ANOVA was applied and mean comparison was carried out using Duncan's multiple range test (Steel &Torrie, 1980). Statistical analysis was accomplished by the SPSS statistic program for Windows. Mean ± SD and significant differences or non-significant differences were reported.

3. Results and Discussion

3.1 Color of Liang Vegetable Leaves

The color of Liang vegetable leaves after categorizing into 3 types is shown in Table 1. Average color of old leaves showed the highest greenness (-a*) followed by the medium and young leaves, respectively ($p<0.05$), while lightness (L*) and yellowness (b*) of old leaves were lower than did medium and young leaves ($p<0.05$).

Table 1: *Color (L* a* b*) of Liang leaves*

Color of leaves	*L**	*a**	*b**
Old	110.26 ± 3.97^{ns}	-10.90 ± 1.80^{a}	27.66 ± 3.98^{b}
Medium	115.26±3.01	-5.93 ± 0.50^{b}	36.33 ± 2.73^{a}
Young	115.36±1.15	3.36 ± 1.02^{c}	35.10 ± 1.04^{a}

Mean ± SD from 10 determinations

$^{a-c}$in the same column indicate significant differences ($p<0.05$)

^{ns}indicatenon-significant difference

3.2 Effect of Maturity of Leaves on the Rank Smell of Liang Vegetable

The result showed that the medium leaves obtained the highest score of smell preference, followed by old leaves and young leaves ($p<0.05$) respectively (Table 2). Thus, the medium leaves were selected for the next step of product development.

Table 2: *Maturity Quality of Liang Vegetable from Sensory Evaluation*

Maturity of leaves	Texture	Color	Smell	Overall liking
Old	4.87±27[c]	4.40±1.42[c]	5.53±1.16[b]	4.13±1.33[c]
Medium	7.33±1.02[a]	7.47±1.10[a]	7.73±0.58[a]	7.47±1.10[a]
Young	5.70±0.98[b]	5.60±1.32[b]	4.87±0.90[c]	5.40±0.96[b]

Mean ± SD from 30 determinations

[a-c]in the same column indicate significant differences ($p<0.05$)

3.3 Effect of Drying Temperature on Sensory Evaluation of Liang Vegetable

The temperature of drying at 70°C was appropriated for the production of crispy Liang vegetable, when the sensory evaluation including texture, color, smell, crispness and overall liking was tested ($p<0.05$)(Table 3). Drying at 70°C was selected for the next experiment, frying.

Table 3: *Sensory Quality of Dried Liang Vegetable at Different Drying Temperatures*

Drying temperature (°C)	Texture	Color	Odor	Overall liking
60	5.33±5.88[b]	4.93±0.88[b]	4.87±1.01[b]	4.40±0.81[b]
70	7.47±1.04[a]	7.20±0.84[a]	7.20±0.86[a]	7.47±0.90[a]
80	5.13±0.73[b]	4.87±0.90[b]	4.87±1.14[b]	4.40±0.89[b]

Mean ± SD from 30 determinations

[a-c]in the same column indicate significant differences ($p<0.05$)

3.4 Effect of Frying Temperature on Sensory Quality of Liang Vegetable

After drying Liang vegetable samples at 70°C, they were subjected to frying at 60, 70, or 80 °C. The temperature of frying at 60°C was suitable for the production of crispy Liang vegetables, when the sensory evaluation including texture, color, smell, crispness, and overall liking was evaluated ($p<0.05$)(Table 4). Frying at 60°C exhibited the highest score among others. The photographs of dried and fried Liang vegetable products are shown in Figure 1.

Table 4: *Sensory Quality of Fried Liang Vegetable at Different Frying Temperatures*

Frying temperature (°C)	Texture	Color	Odor	Crispness	Overall liking
60	7.87±0.81[a]	7.70±0.70[a]	7.80±0.70[a]	7.78±0.73[a]	7.93±0.70[a]
70	5.40±0.62[b]	5.67±0.60[b]	5.73±0.58[b]	5.87±0.6[b]	5.93±0.53[b]

80	4.67±0.80[c]	4.20±0.66[c]	3.93±0.79[c]	4.67±0.71[c]	4.40±0.62[c]

Mean ± SD from 30 determinations

[a-c]in the same column indicate significant differences ($p<0.05$)

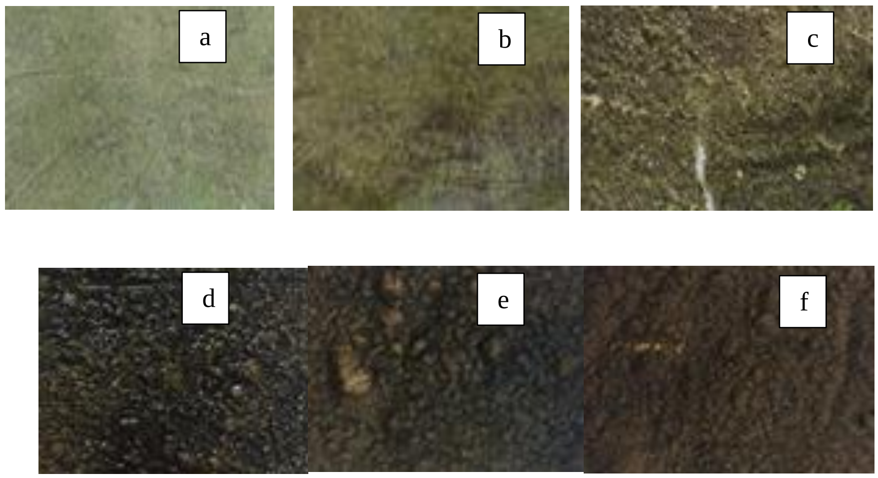

Figure 1: *Crispy Liang Vegetable Oven Dried at 60 (a), 70 (b) and 80 (c)°C and Subjected to Frying at 60 (d), 70 (e), and 80 (f)°C after Dried at 70°C*

3.5 Characteristics of Crispy Liang Vegetable Product

Attributes of the finished product are shown in Table 5. The texture (hardness) of crispy Liang vegetables measured by texture analyzer is 301.79g. Aw was lower than 0.6 that keep it safe from multiplying of mold (McSwan, 2004), however, keeping in dry atmosphere packaging was also needed. Yeast and mold of the finished product were conformed to the safety of Thailand community product standards. The crispy Liang vegetable product also possessed antioxidant activity so that it could be served as a functional food.

Table 5: *Characteristics of Crispy Liang Vegetable Product*

Characteristics	Finished product
Hardness (g)	301.79
a_w	0.47
Yeasts and Molds(cfu/g)	2.2
Antioxidant activity (%)	55.06

Mondal et al. (2019) also reported that the tray drying method is better in water removal, high yield, and stronger antioxidant property in few leafy and non-leafy vegetables of North-East India. Maric et al. (2019) concluded that physical characteristics (color, total soluble solids, and conductivity) and chemical characteristics (total phenolic compound, antioxidative property, ascorbic acid, and β-carotene) of dried root vegetables could be forecasted from root type of vegetables and drying method. Maseko et al. (2019) found that sun-drying retained higher flavonoid and tannin content than shade and oven drying in Africa leafy vegetables.

For frying, Da Silva et al. (2008) reported that most of the fruit and vegetable-based snacks retained original colors when vacuum fried. Sensory panelists liked vacuum-fried snacks for color, texture, taste, and overall quality. The traditional-fried snacks exhibited excessive darkening and scorching and concluded that the vacuum frying method can give high-quality snacks. Chiou et al. (2012) concluded that oil is absorbed by food and becomes part of the diet during frying. French fries contain vitamin E, phytosterols, polyphenols, squalene, triterpenes, and carotenoids after frying and polyphenols retained inside food tissue more than in oil. Therefore, French fries might contain oil-derived health-promoting micro-constituents. Kidmose et al. (2006) found that amount of β-carotene occurred during frying counted on frying duration and the size of samples. β-carotene was found during frying in leafy vegetables and β-carotene extracted into the frying oil was observed in low amounts of sweet potato shreds. Kalogeropoulos et al. (2007) showed that shallow frying resulted in the loss of antioxidants in frying oils and vegetables fried in virgin olive oil obtain an additional intake of α-tocopherol, terpenic acids, and polyphenols. Cui et al. (2017) reported that stir-frying could generate trans-fatty acid than native vegetable salad, pan-frying, and deep-frying. After frying, rice bran oil had higher trans-fatty acid content than peanut oil, soybean oil, rapeseed oil, corn oil, sunflower seed oil, rice bran oil, olive oil, sesame oil, linseed oil, and peony seed oil, while the influence of frying processes on olive oil was the lowest. Esposto et al. (2015) found that phenolic extract from an olive by-product can use to improve a frying oil performance since phenolic extract in frying oil could preserve α-tocopherol against oxidation.

4. Conclusion

Liang vegetable is rich in the bioactive compound and more popular for consumption in southern Thailand. Therefore, Liang vegetable product was developed as a functional snack food with antioxidant activity, and the quality of the finished product was monitored. The quality of crispy Liang vegetable was governed by drying and frying conditions. The crispy Liang vegetable product possessed antioxidant activity and conformed to the safety of community product standards. Thus, the crispy Liang vegetable product could be the potential for developing to vegetable-based snacks for consumer compliance. However, a study on shelf life, storage stability, and appropriate packaging for the finished product were needed to be done in future research.

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