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การเปรียบเทียบผลของกระบวนการแปรรูปด้วยความดันสูงและการฆ่าเชื้อด้วยความร้อนต่อการเปลี่ยนแปลงคุณภาพสับปะรดภูแลพิวเร่

Comparative Analysis of High Pressure Processing and Conventional Heat Treatment on the Quality Attributes of 'Phulae' Pineapple Puree

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บทคัดย่อ

งานวิจัยนี้มีวัตถุประสงค์เพื่อศึกษาผลของการแปรรูปด้วยกระบวนการความดันสูง (HPP) ที่ระดับความดัน 400 และ 600 เมกะปาสคาล เป็นเวลา 10 นาที) เปรียบเทียบกับการใช้ความร้อน (HT) (80 °C เป็นเวลา 10 นาที) ต่อการเปลี่ยนแปลงคุณภาพของสับปะรดภูแลพิวเร่หลังการแปรรูปและเมื่อเก็บรักษาที่อุณหภูมิ 4±1 °C เป็นเวลา 1 สัปดาห์ พบว่า ไม่มีความแตกต่างกันอย่างมีนัยสำคัญทางสถิติ ($p>0.05$) ในด้านคุณสมบัติทางเคมีกายภาพ เช่น ความเป็นกรดที่สามารถไทเทรตได้และ pH ระหว่างตัวอย่าง HPP และ HT หลังการแปรรูปและระหว่างการเก็บรักษา อย่างไรก็ตาม พบว่าของแข็งที่ละลายได้ทั้งหมดของตัวอย่างที่แปรรูปด้วย HT นั้นสูงกว่าตัวอย่างที่ผ่านการแปรรูปด้วย HPP นอกจากนี้ ตัวอย่างที่ผ่านกระบวนการ HPP มีปริมาณฟีนอลิกทั้งหมดสูงกว่าอย่างมีนัยสำคัญ ($p\leq0.05$) (333.75±21.24 mg GAE/100g DW) เมื่อเปรียบเทียบกับตัวอย่างที่ไม่ผ่านกระบวนการแปรรูป (316.70±82 mg GAE/100g DW) ในขณะที่ตัวอย่าง HT มีค่าต่ำสุด (303.66±7.60 mg GAE/100g DW) และปริมาณปริมาณฟีนอลิกทั้งหมดมีแนวโน้มลดลงในทุกชุดตัวอย่างเมื่อเก็บรักษา 1 สัปดาห์ สำหรับปริมาณจุลินทรีย์ทั้งหมด ยีสต์และราในตัวอย่าง พบว่า HPP และ HT สามารถลดปริมาณเชื้อเริ่มต้น จาก 5.27±0.19 และ 4.55±0.18 log CFU/mL ให้ลดลงเหลือน้อยกว่า 2.40±0.00 และ 2.18±0.00 log CFU/mL ตามลำดับ สรุปได้ว่า การเปลี่ยนแปลงคุณสมบัติทางเคมีกายภาพและจุลินทรีย์ของตัวอย่างที่ผ่านกระบวนการ HPP และ HT กับผลิตภัณฑ์สับปะรดภูแลพิวเร่มีความใกล้เคียงกัน ในขณะที่การใช้กระบวนการ HPP สามารถเพิ่มปริมาณฟีนอลิกทั้งหมดของตัวอย่างได้

คำสำคัญ: กระบวนการแปรรูปด้วยความดันสูง สับปะรดภูแลพิวเร่ การเปลี่ยนแปลงคุณภาพ

Abstract

The objective of this research was to study the effects of high pressure processing (HPP) at pressure levels of 400 and 600 MPa for 10 minutes compared with heat treatment (HT) (80 °C for 10 minutes) on quality changes of 'Phulae' pineapple after processing and storing at 4±1 °C for 1 week. It was found that there was no significant different ($p>0.05$) in terms of physiochemical properties such as titratable acidity and pH between HPP and HT samples after treatment and during storage. However, the total soluble solids of the HT samples were observed to be higher than those of HPP sample. HPP treated samples had significantly ($p\leq0.05$) higher total phenolic compound (TPC) (333.75±21.24 mg GAE/100g DW) compared to the fresh samples (316.70±82 mg GAE/100g DW) while HT samples had the lowest value of 303.66±7.60 mg GAE/100g DW on day 0. All treatments resulted in a decrease in TPC value after storage. Regarding microbial attributes, both HT and HPP treatments effectively reduced aerobic plate count and yeast and mold counts of the fresh sample from 5.27±0.19 and 4.55±0.18 log CFU/mL to less than 2.40±0.00 and 2.18±0.00 log CFU/mL, respectively. Both HPP and HT treatments had similar effects on the physiological and microbiological properties of 'Phulae' pineapple puree. However, HPP treatment was more effective in increasing the total phenolic content.

Keywords: high pressure processing, 'Phulae' pineapple puree, quality changes

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Introduction

‘’Phulae’ pineapple (*Ananas comosus* L. Merr), a sub-variety of Queen group pineapple, is one of the popular pineapples grown in Thailand. Known as the Geographical Indication (GI) of Chiang Rai province, Thailand, this variety has sweet taste with small round shape, crunchy texture, light-yellow color pulp, and very distinctive aromatic pineapple smell (Kongsuwan *et al*., 2009). Grown all year round, its oversupply and the postharvest poor handling could lead the price to drop. Therefore, further processing could be used as an alternative. High pressure processing (HPP) is one of the novel processing that use minimal heat, it could maintain sensory properties and nutritional value of the product while prolonged its shelf life. Despite recent studies in HPP, people are still comparing its effectiveness with conventional heat treatment (HT). Therefore, the objective of this research is to study the effect of high pressure processing (HPP) and heat treatment (HT) on quality changes of ‘Phulae’ pineapple puree during storage.

Materials and Methods

1. Plant Material and Pineapple Puree Processing

Fresh and fully ripened ‘Phulae’ pineapple (*Ananas comosus* L. Merr) were sourced from local farmer. Harvested in May 2023 in Chiang Rai province, these pineapples were received peeled, free from external defect, and with total soluble solid approximately 13-15 °Brix. The pineapples were washed, cut, and blended using commercial blender (Philips Blender, model HR2120, Indonesia) at speed 5 for 30 seconds. All samples were then packed in LLDPE pouches (8 x 14 cm), each containing 65 grams. The fresh and HPP-treated samples were pre-packed, while the HP-treated samples were packed post-treatment.

2. Heat Treatment, High Pressure Processing, and Analysis

Heat treatment was carried by heat up the puree in commercial pot at 80℃ for 10 min, cooled down before packaging. For high pressure processing, the packaged sample were treated at 400 and 600 MPa for 10 minutes, using high-pressure unit (Bao Tou KeFa High Pressure Technology Co., Ltd., China), with 3L capacity, water as the transmitting medium and processing temperature 25℃.

Processed pineapple puree was directly analyzed using the pH meter (FiveEast™ FE20-1, Mettler-Toledo AG, Switzerland), refractometer (PAL-1, ATAGO, Japan) and acidity meter (PAL-Easy ACID F5, ATAGO, Japan). Result of total soluble solid were expressed as °Brix and the titratable acidity were expressed as % of titratable acidity (TA). For color analysis, CIE L*a*b* color value was determined in triplicate using color spectrophotometer (model CM-600d, Konica Minolta, Inc., Japan). Total phenolic compounds were determined by Folin-Ciocalteu method (International Organization for Standardization, 2005) with some modification, including the adaptation of the method to 96-well microplate format. The assay was carried out by adding 125 µL 10% (v/v) Folin-Ciocalteu phenol reagent to 25 µL sample extract then 100 µL 7.5% (w/v) sodium carbonate in the microplate. The mixture was shaken and incubated for 1 h in the dark before read at 765nm. Gallic acid was used a standard and result were expressed as gallic acid equivalent (GAE) per 100 g of dry weight (DW). In term of microbial properties, the aerobic microbial count was determined by using 3M Petrifilm™ Aerobic Count Plate (AOAC official method 990.12, 2002) with incubation at 35 ± 1°C for 48 ± 3 hours while yeast and mold count were determined by using 3M Petrifilm™ Yeast and Mold Count Plate (AOAC official method 997.02, 2002) with incubation at 20-15°C for 5 days. All analysis were done right away after the treatment and 7 days after sample stored at 4±1 ℃. All the data were analyzed using analysis of variance (ANOVA) and Duncan’s multiple range test at 95% ($p<0.05$) confident level. IBM SPSS Statistic 26 was use as the software to analyze the data and presented as means ± standard deviation (SD). For the analysis, all test were conducted in triplicate.

Results and Discussion

There was no significant difference in term of pH and titratable acidity (TA) between sample before and after the storage, with pH around 3.96-4.01 and TA around 0.66-0.73%. Total soluble solids (TSS) between fresh and HPP sample were relatively similar around 13.79-14.50 but HT sample had higher TSS around 14.69-14.83 due to water evaporation during the treatment. Minor and none significant changes in term of pH and TA showed that HPP has non-destructive nature on covalent bonds in the product matrix (Ravichandran *et al*., 2023). The result is in accordance with Wu *et al*. (2021) in which both HT and HPP pineapple juice has no significant changes of pH, TA, and TSS during 7 days of storage period compared with the fresh juice.

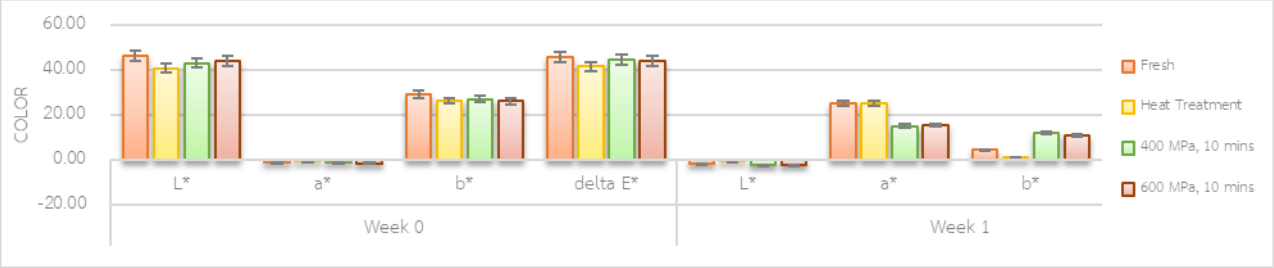

Figure 1. Color analysis of 'Phulae' pineapple puree

The L* value (lightness) of the samples remained nearly the same before and after storage, with the HT sample had the lowest value, indicating it was darker compared to the fresh and both HPP samples. The b* value (yellowness) of the HPP samples decreased after storage. These could be due to the pigment degradation, particularly carotenoid which contributed to the yellowness of the product. Similar study in pineapple puree also showing almost similar trend (decreased L* and b* value) during storage (Chakraborty *et al*., 2016). The HPP treated samples exhibited more significant color changes (delta E*) compared to the other samples, with higher changes in HPP sample at 400 MPa for 10 minutes.

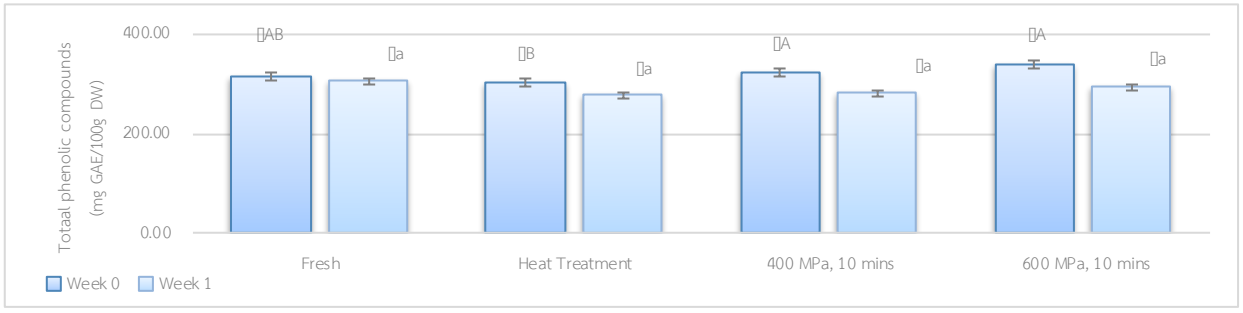

Figure 2. Total phenolic compound of 'Phulae' pineapple puree (Data of different alphabets in the same color block (week 1 or 2) were different with statistical significance ($p<0.05$))

HPP treated sample showed significant ($p<0.05$) higher TPC after treatment, with higher pressure showed higher TPC value, while HT sample had had significantly ($p<0.05$) lowest TPC (Figure 2). The decrease in TPC in HT sample is attributed to the sensitivity of these compounds to high temperature. In the other hand, the higher TPC in HPP treated sample might be due to pressure that disturb the cell wall and cell matrix which enhance extraction and thermal solubilization of phenolic compounds in the puree matrix (Chakraborty *et al*., 2016). Previous studies found that HPP could retain total phenolic compounds in mango puree (Elizondo-Montemayor *et al*., 2020), After storage, the TPC value decreased in all the sample and there were no significant differences ($p<0.05$) between sample. The decrease of TPC during storage might be due to the phenolic compound oxidation or participation of phenolic compounds in different reaction such as browning, condensation, polymerization and anthocyanin degradation (Chakraborty *et al*., 2016).

Table 1 Microbial properties of 'Phulae' pineapple puree

Treatment	Aerobic Plate Count (log CFU/mL)		Yeast and Mold Count (log CFU/mL)	
	d-0	d-7	d-0	d-7
Fresh	5.27 ± 0.19[a]	5.87 ± 0.11[a]	4.55 ± 0.18[a]	5.88 ± 0.12[a]
HT	<2.40 ± 0.00[b]	<2.40 ± 0.00[b]	<2.18 ± 0.00[b]	<2.18 ± 0.00[b]
HPP 400 MPa, 10 mins	<2.40 ± 0.00[b]	<2.40 ± 0.00[b]	<2.18 ± 0.00[b]	<2.18 ± 0.00[b]
HPP 600 MPa, 10 mins	<2.40 ± 0.00[b]	<2.40 ± 0.00[b]	<2.18 ± 0.00[b]	<2.18 ± 0.00[b]

*Value expressed mean ± standard deviation. Data of different alphabets in the same column were different with statistical significance ($p<0.05$)

As shown in Table 1, APC and YM count in fresh pineapple puree were 5.27 and 5.28 (log CFU/mL), respectively, which indicating that fresh sample poses a high risk of microbial safety. HT and HPP treatments were able to reduce microbial counts by more than 2 log in both APC and YM, which indicating both treatments are effective in reducing the microbial count in the 'Phulae' pineapple puree. The microbial count of the fresh samples increased during storage, whereas the microbial count of the HT and HPP samples remained stable. The result was consistent with the previous study in pineapple juice which HPP at 500 MPa for 10 mins and HT at 95°C for 3 mins could reduce more than 4 log unit of microbes with stable microbial count for 21 days (Wu *et al*., 2021).

Summary

HPP treatments at 400 and 600 MPa for 10 minutes effectively preserved the physiochemical properties and bioactive compounds, such as TPC, of 'Phulae' pineapple puree, demonstrating comparable microbial reduction of HT. However, HPP samples exhibit color changes during storage.

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