Comparison of Nitrate Content in ‘Smooth Cayenne’ Pineapple Flesh Related to Its Different Cut Sections, Maturity and Crop Season

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***Abstract*—High nitrate (NO_3) level in pineapple flesh affected to cans. It is one of main problems in pineapple canning factory. Pineapple with high NO_3 content is required to screen out before feeding to a process of the factory. Knowledge of NO_3 content in pineapple is important for quality control due to checking of NO_3 content in pineapple is random. There is still no scientific evidence to support what a suitable procedure for nitrate inspection should be handled. Therefore this is research was aimed to study the level of nitrate in difference part of pineapple fruit (top, middle and bottom) related to maturity stage and crop seasons. A batch of 82 pineapple fruits (harvested in summer and rainy season) was used in this research. Each sample was divided into 3 parts (top, middle and bottom). The amount of nitrate in each part of pineapple flesh was determined by HPLC. By statistical analysis, the level of nitrate at different cut sections of pineapple flesh was no significant difference. The nitrate level of pineapple flesh with lower brix and acid ratio (B/A<23) was significantly different to those of flesh with higher brix and acid ratio (B/A>23). The nitrate level of pineapples flesh harvested in summer season was significantly different to those of flesh harvested in rainy season. Therefore, NO_3 content in pineapple wasn’t related to cut section but it was related to maturity and crop season.**

***Index Terms*—pineapple, flesh, nitrate, inspection**

I. Introduction

The pineapple is one of main economic fruits in Thailand. In 2013, Thailand was the largest exporter of canned pineapple and concentrated pineapple juice in the world [1]. Smooth Cayenne is one of four main commercial cultivars of pineapple for productions in the world [2]. High level of nitrate (NO_3) may corrode cans and make pineapple juice dark [3]. Nitrate in pineapple flesh occasionally affects the cans, likely by reacting with the tin coating, resulting in a corrosive chemical reaction [4]. Today; high nitrate level is a common problem in Thailand. The trend of finding more pineapples with high level of nitrate in Thailand is becoming more serious [5]. Therefore, nitrate content allowance in pineapple flesh must be controlled by the factory before feeding to the process. In the real practice of the factory, nitrate content in flesh can be checked randomly at the middle of fruit about 2.5-3.7 centimeters deep from the peel by nitrate strip. However, there is still no scientific evidence to support where a suitable cut section of fruit for nitrate should be checked.

There was a report presented that nitrate level in plant was depended on plant part, stage of maturity and environmental condition [6]. Tomatoes ripened on tree had significantly higher nitrates than tomato ripened after harvest [7]. Nitrate concentration in leaves of young cabbage was lower than older leaves [8]. Ability of nitrate accumulation depends on plant species and plant parts [9]. In Thailand, most of pineapples are harvested by looking at the outside appearances from skilled labors [5]. The peel color of pineapple is used to define maturity stage. The peel color of Smooth Cayenne for maturity determination is classified to 6 stages: CS1= green, CS2 = breaker, CS3 = 25% yellow, CS4 = 50% yellow, CS5 = 75% yellow and CS6 = 100% yellow [10]. However, the index from destructive method, brix and acid ratio (B/A), is mainly used to evaluate quality of pineapple fruit [11]. A research paper reported that the little difference in maturity of pineapple might be obtained the large difference in quality of pineapples [12]. The harvested season perhaps affected to the quality of pineapple fruits [13].

Therefore the purpose of this research was to study the level of nitrate in difference part of pineapple fruit (top, middle and bottom), maturity stage and crop season.

II. Materials and Methods

A. Fruit Sampling

Commercial quality fruits as delivered to a pineapple factory of ‘Smooth Cayenne’ pineapple (0.9 to 1.5kg per fruit and N= 82) were purchased from farm in Rachaburi province, Thailand. Two crop seasons of summer (March - May, 2013) and rain (July-August, 2013) were selected in this research. Fig. 1, three groups of different peel color (25%, 50% and 75% of yellow) were collected and transported to the laboratory of the Agro-industry Faculty, King Mongkut's Institute of Technology Ladkrabang, Bangkok. The samples were kept in the ambient temperature and subjected to analysis within 7 days.

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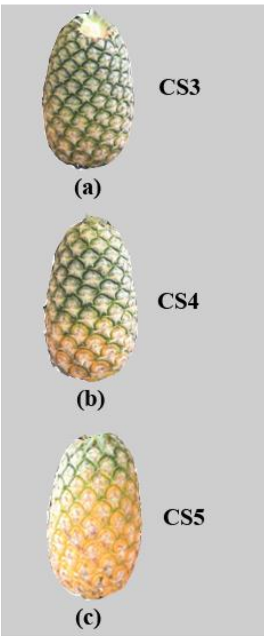

Figure 1. Pineapples were grouping by different peel color: (a) CS3 = 25% yellow, (b) CS4 = 50% yellow and (c) CS5 = 75% yellow.

B. Sample Preparation

Each fruit was peeled by a sharp knife. Pineapple flesh was then cut into 3 parts (top, middle and bottom) as shown in Fig. 2.

Figure 2. Pineapples were cut into three parts: top, middle and bottom.

Each piece of pineapple flesh was chopped with a knife. Pineapple flesh approximately 5 g was frozen in liquid nitrogen and stored in -20 ℃ until extraction nitrate. Another flesh was used to extract pineapple juice for determine brix and acid ratio (B/A).

C. Nitrate from Pineapple Flesh Determination

Each pineapple flesh sample was then thawed, added with 25 ml mobile phase [5 mM tetrabutylammonium hydrogen sulphate : 0.01 M n-octylamine (90:10)] in a flask with blending by magnetic stirrer for 10 minutes, and filtered by a 0.45 micron syringe applied from Chou et al. [14]. The filtrate sample was then injected to HPLC. HPLC equipped with a UV absorbance detector with gradient elution and a direct UV spectrophotometric method was used for nitrate measurement.

Chromatographic separation was performed on a EurosilBioselect 300-5 C18 column (125x4mm i.d.) (Knauer, Germany). The mobile phase were flowing at 0.5 ml/min, at a temperature at 40°C, volume of 5 µL sample was injected and UV spectrometer (Agilent 1100, United States) at 210 nm was used for nitrate determination [15].

D. Determination of Total Soluble Solids (TSS)

TSS was determined by using a digital refractometer (Atago PAL-3, Japan) and °Brix was recorded.

E. Determination of Titratable Acidity(TA)

TA was estimated by titrating 5 ml of pineapple juice with 0.1 N Sodium hydroxide (NaOH) up to pH 8.2. The amount of NaOH solution using was recorded. The TA was also calculated. The result was reported as % of citric acid applied from Ahmad et. al. [16].

F. Determination of Brix: Acid Ratio

The brix and acid ratio (ripening index) was calculate by using a formula

B/A = °Brix value/ % of citric acid

G. Statistical Analysis

All data were analysed by using R Statistical Software.

III. Results and Discussion

A. Nitrate Level in Different Cut Sections of Pineapple Flesh

Fig. 3 shows the average and deviation of NO_3 content in pineapple flesh from 82 fruits at different cut sections such as top, middle and bottom. It showed that averaged nitrate at the middle part of pineapple fruits was lowest (14.55 ppm) and the highest averaged nitrate was at the bottom part (16.55 ppm). However the result of statistical analysis showed that NO_3 content at different cut sections of pineapple flesh was no significant difference according to the result of one-way ANOVA ($p>0.05$). It means that NO_3 content in pineapple flesh can be checked at every part of fruit for quality control of the factory.

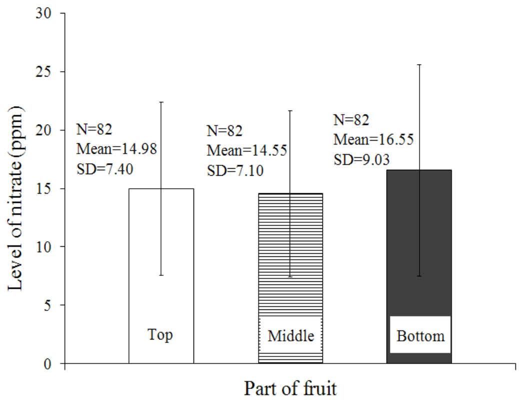

Figure 3. NO_3 content in pineapple flesh at different cut sections of pineapple fruit

B. Effect of Maturity Index by Peel Color on Nitrate Level in Pineapple Flesh

Fig. 4 shows the average and deviation of NO_3 content in pineapple flesh from 82 fruits (CS3, N=18, CS4, N=29 and CS5, N= 35). It showed that averaged nitrates of CS3, CS4 and CS5 were 11.98, 12.39 and 19.56 ppm, respectively. The highest averaged nitrate was in CS5 and it was quite different from CS3 and CS4. The result of statistical analysis showed that NO_3 content at different peel color was significant difference according to the result of one-way ANOVA ($p<0.05$).

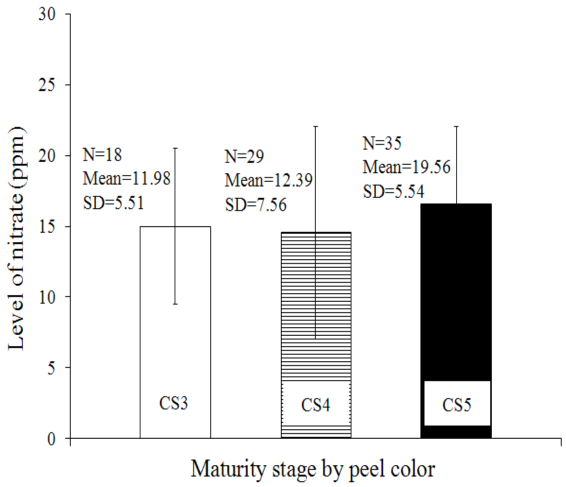

Figure 4. NO_3 content in pineapple flesh at different peel color

C. *Effect of Brix: Acid Ratio(B/A)on Nitrate Level in Pineapple Flesh*

In Fig. 5, it showed that the level of nitrate in pineapple flesh was related to maturity as indicated by brix and acid ratio. It showed that averaged nitrates of pineapple flesh with lower brix and acid ratio (B/A<23, N= 40) and higher brix and acid ratio (B/A≥23, N= 42) were 13.98 and 16.68 ppm, respectively. The result of statistical analysis showed that there was significant difference in NO_3 content of pineapple flesh with lower brix and acid ratio and those of flesh with higher brix and acid ratio according to a two tailed t-test ($p<0.05$). The result showed that pineapple flesh with lower B/A contained lower NO_3 content.

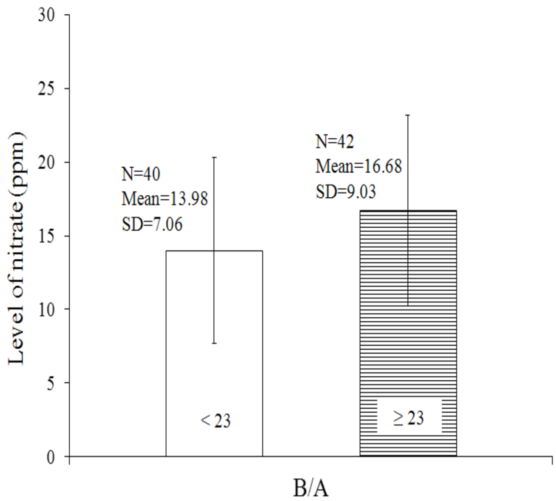

Figure 5. NO_3 content and B/A in pineapple flesh

D. *Effect of Season on Nitrate Level in Pineapple Flesh*

A comparison of nitrate level in pineapple flesh harvesting in summer (N=17) and rainy season (N=65) was considered as shown in Fig. 6. It showed that averaged nitrates of pineapple flesh in summer and rain were 12.45 and 16.12 ppm, respectively. The result of statistical analysis showed that there was significant difference in NO_3 content of pineapple flesh harvested in summer season and those of flesh harvested in rainy season according to a two tailed t-test ($p<0.05$). The result showed that pineapple flesh harvested in rainy season contained higher NO_3 content. This result was corresponding to a study of Ruksumruad [17] that measured nitrate content in pineapple juice using Ion meter. The results showed averaged nitrate content was 4.9 ppm in pineapple growing in dry season and 215.0 ppm in pineapple growing in rainy season. However, uptake of nitrate content into pineapple fruit also depended on environment during plantation [18].

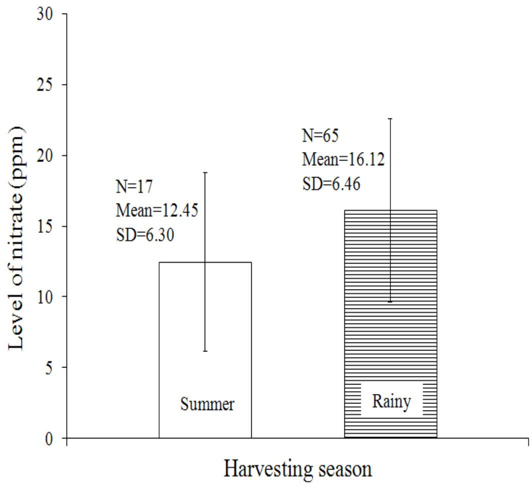

Figure 6. NO_3 content in pineapple flesh in different crop season.

IV. Conclusion

In summary, NO_3 content of pineapple flesh in different cut section of the fruit was not significantly different. It was interesting that pineapple with more yellow color on peel (75% of yellow) contained higher NO_3 content as well as pineapple with higher brix and acid ratio also contained more NO_3 content. Besides, nitrate level of pineapple flesh harvested in rainy season was higher than those of flesh harvested in summer season. However, the results of nitrate in pineapple flesh perhaps varied due to other factors such as fertilizer and environment. These results were useful for the pineapple canning factory to handle the suitable procedure of nitrate inspection in pineapple.

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