



VARIATION IN CINNAMON BARK CHEMICAL COMPOSITION AMONG VARIETIES IN RELATION TO PEELABILITY

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Ceylon cinnamon is valuable spice rich in volatile oils and bioactive compounds. However, harvesting is restricted to specific times of the year due to peeling difficulties in the bark during certain physiological stages and dry weather, creating a significant challenge in meeting the constant, year-round demand. This study investigated the interplay between chemical composition and peelability of the bark across three *Cinnamomum zeylanicum* varieties: Sri Gemunu, Sri Wijaya, and Common. Ten samples were collected from each variety, depending on the peelability of the bark. The bark oil was extracted using the Clevenger apparatus, which adapted the hydrodistillation method, to analyse its chemical composition using a Gas Chromatography (GC) instrument. Further, polyphenols, flavonoids, and tannins in powdered bark samples were determined using UV-VIS spectroscopy. The data obtained were analyzed using two-way ANOVA, considering variety and peelability. Gemunu and Wijaya varieties had shorter peeling times, while non-peelable samples took longer times than their peelable counterparts. Gemunu had the highest oil yield, and peelable samples showed slightly higher oil volume, indicating a marginal significance between peelability and oil yield ($p=0.0666$). Using GC reference data, α -pinene, Eucalyptus, β -caryophyllene, Linalool, Trans-cinnamaldehyde, Cinnamyl acetate, and Eugenol were identified among the constituents present in the bark oil. Trans-cinnamaldehyde represented the greatest concentration in all peelable and non-peelable bark samples (55% to 65%), with cinnamyl acetate as the next most prominent compound. The others were found in less than 10%. However, in Wijaya, cinnamyl acetate was found to be higher in non-peelable samples (23.48%) than the peelable ones (17.49%), and again, the opposite trend was observed for the common variety. There was no significant difference observed between the peelable and non-peelable samples, which indicates that both of these types can be used equally in their applications, even in less favorable conditions. Non-peelable bark of Wijaya variety had the highest flavonoid content, which was 2571 mg Quercetin Equivalents/g powder, and polyphenol content, which was 250 mg Gallic Acid Equivalents/g powder. Tannin was higher in non-peelable bark of the Gemunu variety (868 mg Tannic Acid Equivalents/g powder). Therefore, the less-peelable bark could also be a good source of bioactive compounds.

Keywords: bioactive compounds, cinnamon, chemical composition, peelability

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INTRODUCTION

Ceylon cinnamon, also known as *cinnamomum zeylanicum*, is native to Sri Lanka and is renowned for its application in the food, pharmaceutical, personal care, and beauty industries (Li *et al.*, 2013). The global demand for cinnamon is extremely high throughout the year. However, the harvesting of the cinnamon bark is often limited due to the difficulty of peeling it. Higher peelability efficiently increases productivity, quality, and economic value. This study investigates the variations in the chemical composition of peelable and non-peelable cinnamon bark across three different varieties: Sri Gemunu, Sri Wijaya, and Common. In addition, we determined the presence of bioactive compounds in cinnamon bark and quantified the content of bioactive compounds present.

METHODOLOGY

The cinnamon bark samples were obtained from the National Cinnamon Research and Training Centre in Matara, Sri Lanka. A total of thirty samples were collected with five peelable plants and five non-peelable plants from each variety. The cinnamon bark oil samples were extracted by the hydro-distillation method using a Clevenger apparatus (Jayaprakasha *et al.*, 1997). The materials used for the extraction were a 1000 mL round-bottom flask, a heating mantle, the Clevenger arm, a condenser, and dried cinnamon bark samples. The major volatile compounds in the extracted oils were identified employing Gas Chromatography (GC) by comparing their retention times with those of standards. The results were statistically analysed using two-way ANOVA at the 5% significance level to assess the significant difference in peeling time and extracted oil content with their peelability. The total amounts of polyphenols, flavonoids, and tannins were quantified using a UV-Vis spectrophotometer. The total phenolic content (TPC) was determined using the Folin-Ciocalteu method, total flavonoid content (TFC) using the Aluminum Chloride colourimetric method, and total tannin content (TTC) using the Folin-Denis method (Lopes *et al.*, 2022). And those results were also subjected to the same statistical analysis as described previously.

RESULTS AND DISCUSSION

The peeling time of peelable samples proved shorter compared to non-peelable samples. However, the Common variety required the most extensive time for peeling indicating complicated processing methods. To get an overview of the peelability and non-peelability of the plants, the peeling time was calculated for the average dry



weight of 1 kg of the sample. The varieties with higher dry weight take shorter peeling times as compared to the lighter varieties as shown in Table 1. However, there was no significant main effect of peelability on peeling time per 1 kg of sample dry weight (PT). Also, the different types of varieties do not influence PT. The oil yields obtained from the extraction showed noticeable differences between peelable and non-peelable cinnamon bark samples, as illustrated in Table 1. The peelable samples produced consistently greater oil yields than the non-peelable samples. For the peelable ones, Gemunu had the highest volume of oil produced, while Wijaya produced the least amount. Non-peelable samples are also variable; Gemunu produced low oil content. On average, Gemunu has a higher oil yield than Wijaya and Common varieties. This aligns with the report published by Wijeweera *et al.* (2020) that had the highest oil volume in Gemunu variety. This variation might be due to the genetic differences present among the cinnamon varieties. The impact of peelability on the oil volume is significantly found to be quite low, suggesting that peelability has a marginal bearing on oil volume ($P = 0.0666$). However, it is seen that the variety has a big impact on the oil volume, and the difference among them is significant ($P = 0.0448$). The content of trans-cinnamaldehyde, eugenol, cinnamyl acetate, linalool, eucalyptus, and β -caryophyllene was analyzed through a gas chromatography instrument. Notably, trans-cinnamaldehyde was more abundant in all the samples than the other compounds, yet again it was higher in non-peelable samples in the common variety, almost similar in the Gemunu variety, and lower in non-peelable samples in the Wijaya variety. The area percentage in the chromatograms is the highest at 64.58% showing the huge contribution of this compound to the chemical composition of the bark (Senanayake *et al.*, 1978). Cinnamyl acetate comes next, contributing to having 16.18% of the Peak area percentage. This is in accordance with the paper presented by Wijeweera *et al.* (2020) that bark oil had cinnamaldehyde and cinnamyl acetate as the major constituents (>70%). Other notable compounds include linalool (3.32%), eucalyptus (3.76%), and eugenol (1.29%). Components like α -pinene and β -caryophyllene have values of less than 1 % each. As depicted in Table 1, the quantitative data revealed that polyphenols, flavonoids, and tannins existed at higher concentrations in non-peelable samples. The Wijaya variety is higher in phenolic content than all the other samples under investigation. There is not much difference in TPC between the peelable and non-peelable samples in Wijaya. The lowest TPC was observed in the common variety. However, the non-peelable samples in the common variety show a higher concentration of TPC than the peelable samples. In Gemunu, the higher concentration of TPC is shown by the peelable samples. A significant difference exists between the peelable and non-peelable samples regarding TPC ($P < 0.0001$) among the varieties. Moderate TFC values are obtained for the Gemunu samples, and the Gemunu non-peelable samples present slightly better flavonoid content than peelable samples. However, the Common samples have the least TFC. Comparing the results of samples, there are significantly higher flavonoid concentrations for non-peelable samples as contrasted with peelable samples ($P < 0.0001$). The non-peelable samples from the Gemunu variety hold the highest TTC. As the results indicate, the Wijaya samples may not be as high as in tannin content compared with the Common or Gemunu samples. A statistically significant



difference in TTC was also observed among the samples ($P < 0.0001$). Moreover, the Gemunu shows the highest content of bioactive compounds in all three varieties.

CONCLUSIONS

The results obtained from this study concluded that the chemical composition of the cinnamon bark varies based on its peelability. This finding could play a crucial role in determining the best practice for cultivation and harvesting time to obtain the highest yields of the compounds. Non-peelable bark, which is underutilised due to difficulties for cinnamon quill production, can be effectively used to produce cinnamon powder, thus minimizing waste and maximizing yield, as its chemical composition is comparable to peelable bark, ensuring a final product with similar quality and value. From an industrial point of view, understanding the role of peelability can be beneficial when choosing a specific type of cinnamon for particular purposes. For instance, non-peelable cinnamon bark may be ideal for industries that need a high percentage of bioactive compounds, such as the pharmaceutical sector. Collectively, these findings highlight the significance of peelability as one of the key factors that should be considered to enhance cinnamon yields for various applications across several industries.

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Figure and Tables

Table15: Comparison of Peeling Time, Oil Yield, and Phytochemical Content in Different Cinnamon Samples

Sample	Peeling time per 1 kg of dry weight of the sample/min	Average Oil volume/(V±0.01) mL	Average TPC/mg GAE/g (powder)	Average TFC/mg QE/g (powder)	Average TTC/mg TAE/g (powder)
Gemunu peelable	65.35	1.14 (±0.30)	232 (±0.00)	1470 (±0.57)	640 (±0.00)
Gemunu non- peelable	67.60	0.98 (±0.30)	128 (±0.00)	1710 (±0.00)	868 (±0.00)
Wijaya peelable	64.04	0.72 (±0.03)	101 (±0.57)	2519 (±0.57)	608 (±0.00)
Wijaya non- peelable	69.34	0.6 (±0.09)	97 (±0.00)	2571 (±0.57)	627 (±0.57)
Common peelable	63.84	0.92 (±0.09)	20 (±0.00)	137 (±0.00)	76 (±0.00)
Common non- peelable	77.12	0.42 (±0.02)	239 (±0.00)	2352 (±0.00)	734 (±0.00)