Mapping on the origins of cajuput essential oil for its compatibility as *Cajuputs® candy* functional flavour

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Abstract

Cajuput essential oils (CEO) were utilized as a functional flavour in *Cajuputs® candy*. CEO are produced in several areas of Indonesia such as Buru Island, Bupolo, Namlea, Belu, Gelaran, Sendang mole, Tanjung enim, Indramayu, Ponorogo, Mojokerto, Gundih, Kuningan, and Pasuruan. The quality of these CEO, however, might be influenced by its geographical origin. The current product is utilizing CEO originated from Buru Island as its flavouring. The aim of this study was to obtain compatible CEO as alternative functional flavour for *Cajuputs® candy*. The physicochemical properties such as density, refractive index, optical rotation, solubility in alcohol 70% and cineol content were examined. Hedonic test and different from control test were also conducted to evaluate their sensory characteristics. Principal Component Analysis (PCA) was applied to observe the mapping of CEO from different origin based on their physicochemical and sensory properties. The results showed that CEO from Bupolo, Ponorogo and Mojokerto showed good compatibility in terms of the best acceptance rate of taste, aroma and overall attributes, and having the least difference to the reference characteristics.

Introduction

Cajuput essential oils (CEO) derived from *Melaleuca cajuputi* species are known to have antibacterial and antifungal activity related to their bioactive compounds [1,2]. CEO has been long used for tropical medicine, yet it was developed as functional flavour in *Cajuputs® candy*, an Indonesian herbal-based lozenge which was also proved to maintain the oral health from pathogenic microbial infections. Since 1997 this functional candy has been produced by using CEO from Buru island as its main flavouring. However, the availability of this CEO was gradually decreasing since most of their producers had become gold miners. Therefore, it is necessary to explore alternative CEO with compatible flavour characteristics for *Cajuputs® candy*.

Indonesia has many sources of CEO due to the excellent adaptability of the plants to grow both in dry and wetlands or even in swamp areas. However, the quality of CEO seems different depending on the origin. The aim of this study was to obtain compatible CEO, in terms of their physicochemical and sensory properties, as alternative functional flavouring for cajuputs *Cajuputs® candy.*

Experimental

Materials

CEO were obtained from steam distillation of leaves and twigs of cajuput plants (*Melaleuca cajuputi*) collected from 13 different locations, with Buru island CEO used as the reference. Others CEO samples were obtained from private suppliers (Bupolo, Namlea and Belu), Dinas Kehutanan dan Perkebunan Daerah Istimewa Yogyakarta (Gelaran and Sendang mole), Bukit Asam Company (Tanjung enim), and Kesatuan Bisnis

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Mandiri IMKP Surabaya (Indramayu, Ponorogo, Mojokerto, Gundih, Kuningan, and Pasuruan). Peppermint oil was purchased at PT. Brataco Chemika.

Preparation of candy

The original *Cajuputs*® *candy* non sucrose was made based on the procedures conducted by Wijaya [3].

Physicochemical analysis

The physicochemical properties of CEO were examined based on Indonesian national standard for CEO (SNI 06-3954-2006).

Sensory evaluation

The hedonic rating test and different from control test of *Cajuputs*® *candy* were performed for the CEO sensory analysis. They were done according to Meilgaard *et al.* [4]. In case of the hedonic test, the samples were given to the panellists in the block system according to the Balanced Incompleted Block Design [5].

Statistics analysis

Analysis of variance (ANOVA) was conducted to assess significant differences between samples *Cajuputs*® *candy* using the SPSS version 22.0 program (SPSS Inc., Chicago, IL, USA). Dunnet test was performed for the different from control test data while the hedonic test data was analysed by Duncan's test. P value < 0.05 was considered statistically significant. Principal component analysis was performed to map 13 CEO towards their physicochemical properties and hedonic scores using Minitab 16 (Minitab Inc., USA).

Results and discussion

The CEO had different colour, ranging from colourless to greenish. They also had strong cajuput-like odour, except for Belu CEO which was showing off-flavour. As shown in table 1, none of these 12 CEO showed significant differences among the CEO. In addition, they also had a high similarity to the reference except for the cineol content and optical rotation. Most of the CEO samples had a good quality based on SNI standard. Tanjung enim, Gelaran, Sendang mole and Namlea were out of the range due to their lower cineol content.

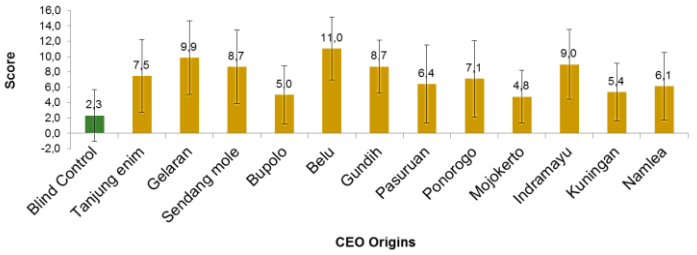


Figure 1: Different from control test of *Cajuputs*® *candy* derived from several CEO in Indonesia (Blind Control = Reference)

Panellists' given response showed that there were significant differences between the samples and the reference ($p<0.05$) on the overall attributes (Figure 1). *Cajuputs*® *candy* with CEO from Belu had the most different sensory characteristic from the reference. It might be due to its strong metallic odour and off-flavour. Similar phenomenon was found on the CEO from Indramayu. On the other hand, Bupolo and

Namlea CEO had a huge similarity with the reference. This could be due to their similar geographical origin. However, the most similar sensory characteristic of CEO in terms of flavour was shown by CEO from Mojokerto. Interestingly, Mojokerto is located on a different island, however, it showed better similarity. It indicated that the compatibility of the CEO is not only due to the geographical impact, but also due some other factors. There should be specific chemical compounds on CEO which could affect their similarity. Similar tendencies were also found on Kuningan, Pasuruan and Ponorogo CEO.

Table 1: Physicochemical properties of CEO from different origins

No	*CEO Origins*	*Analysis parameters*					
		Smell test	*Density*	*Refractive index*	*Optical rotation*	*Solubility in alcohol 70%*	*Cineol content (%)*
		cajuput-like	*0,900 – 0,930*	*1,450 – 1,470*	*(-) 4,00 – 0,00*	*1:1 – 1:10*	*50 – 65*
1	Buru Island (Reference)	cajuput-like	0,915	1,463	(-) 0,10	1:3	50,10
2	Tanjung enim	slightly metallic	0,924	1,470	(-) 0,30	1:3	43,16
3	Gelaran	cajuput-like	0,911	1,468	(-) 7,60	1:3	41,51
4	Sendang mole	cajuput-like	0,913	1,468	(-) 0,40	1:3	46,29
5	Bupolo	cajuput-like	0,917	1,467	(-) 0,35	1:3	54,62
6	Belu	Off-flavour	0,917	1,465	(-) 3,40	1:3	52,78
7	Gundih	cajuput-like	0,910	1,467	(-) 6,10	1:3	51,44
8	Pasuruan	cajuput-like	0,910	1,467	(-) 4,10	1:3	64,79
9	Ponorogo	cajuput-like	0,916	1,465	(-) 5,40	1:3	53,79
10	Mojokerto	cajuput-like	0,913	1,468	(-) 3,40	1:3	56,71
11	Indramayu	Slightly burned	0,914	1,461	(-) 0,50	1:3	57,76
12	Kuningan	cajuput-like	0,915	1,468	(-) 0,90	1:3	60,50
13	Namlea	cajuput-like	0,915	1,466	(-) 2,00	1:3	45,86

The results from the hedonic test results (Figure 2) showed that the level of panellists' preference was influenced also by the origin of the CEO. The results showed that the preferences upon *candy* which was added with CEO from Belu showed the lowest score. CEO from Ponorogo, Mojokerto, Kuningan, Bupolo, and Namlea had a similar preference level, equal to the reference. These results supported the previous finding that the CEO with high similar sensory characteristic to the reference tends to obtain high score of preference level approach to the reference.

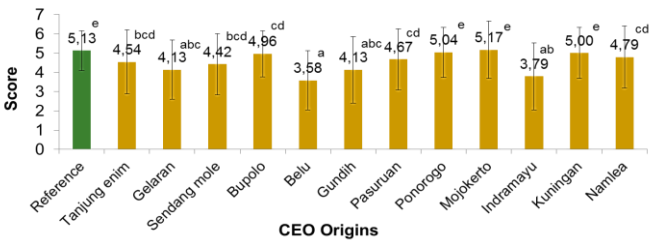
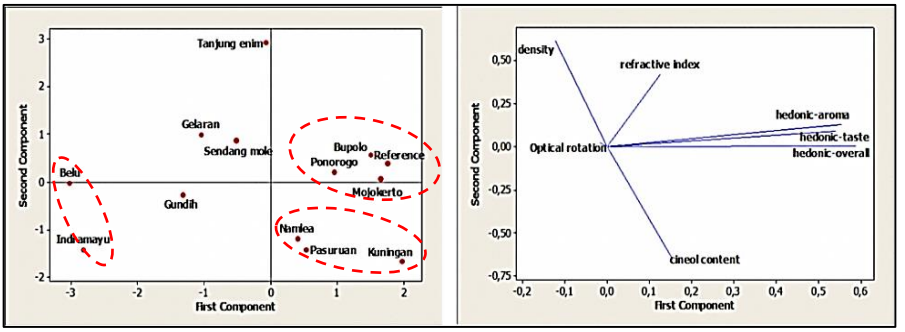


Figure 2: Hedonic test of *Cajuputs® candy* derived from several CEO in Indonesia ($p < 0,05$)

The mapping of the physicochemical properties into the sensory characteristics showed that the CEO from Bupolo, Mojokerto, and Ponorogo were the most potential CEO to be developed as compatible functional flavour ingredients in *Cajuputs® candy*

due to their similarity with the reference (Figure 3). This grouping tends to be dominated by the panellists' preferences in terms of taste, aroma (data not shown) and the overall attributes. Cineol content also gives a significant contribution. The second option comes to the group of CEO from Pasuruan, Kuningan and Namlea.



(a) (b)

Figure 3: Score plot (a) and loading plot (b) PCA of different origins CEO towards its physicochemical properties and sensory characteristics

Moreover, the data proved that although the physicochemical characteristic of the CEOs (Table 1) looks similar to the reference, the sensory characteristics toward the *Cajuputs®candy* showed diversity. Similar with the previous phenomena, Mojokerto, Ponorogo, Kuningan, and Pasuruan CEO which were located in a different island as the CEO reference origin, having similar sensory characteristic as the reference (Figure 1). Surprisingly, not all of the CEOs which met the requirements of SNI standard obtained a good sensory preference level (Figure 2). Otherwise, some CEO those had high level of preferences and high similarity on sensory characteristic actually did not met the requirements of SNI (Pasuruan, Ponorogo and Namlea). Therefore, further studies are necessary to be done in order to investigate the correlation of the CEO origin with their chemicals composition, particularly for the volatiles which contributed to the flavour perception.

Acknowledgments

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