

Aroma volatiles of several obscure tropical fruits and spices

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Abstract

Indonesia is rich in varieties of fruits and spices. Unfortunately, scientific information about them is very limited; meanwhile many of them are approaching extinction. Some of them, *Andaliman* (*Zanthoxylum acanthopodium* DC), *Kwenti* (*Mangifera odoranta* Griff.), *Kawista* (*Feronia limonia* L.), *Jeruk purut* (*Citrus hystrix* L.) and *Pandan wangi* (*Pandanus amaryllifolius* Roxb.) have strong delightful aroma as well as unique bio-activities. Their aromas are attractive to explore deeper, especially due to their potency as natural flavor sources that also possess physiological properties.

Introduction

Indonesia has plenty of tropical fruits, herbs, and spices with their profound delicacies. Some of them have been cultivated and widely known. However, many of them are merely collected from the wild ones and only known by the local tribes or communities. Scientific information about them is very limited.

Many of them are not only releasing delightful unique aroma, but also they may generate exciting trigeminal effects, preserve, and produce beneficial physiological effects. These characteristics would respond properly to the functional flavoring demands. Suitable handling and processing of the material would bring additional benefits to the aromatic plants, especially those that unable to be consumed freshly.

Some potential spice and herbs

Andaliman (*Zanthoxylum acanthopodium* DC) is one of the unique wild spices known by the Batak Angkola and Batak Mandailing, local people in North Sumatera, Indonesia (Hasairin, 1994). *Andaliman* is frequently grouped into *Piperaceae*, and named as *Piper rebesioisides* (Parhusip et al., 1999). However, taxonomically verification of its leaves, stem, roots, and fruits has indicated that this spice is included to the member of *Rutaceae*, and deserved to be named as *Zanthoxylum acanthopodium* DC (Wijaya, 2000).

In North Sumatera, *andaliman* fruit is used to spice many different kinds of meat or fish dishes, such as *naniura*. *Naniura* is a dish made of raw meat or fish, mixed with blood, and then stored all night. *Andaliman* raw extract is proven to have antimicrobial, antioxidant and immunostimulant activity (Wijaya et al., 2000).

Andaliman fruit has fresh citrus like and warm sweet peppery aroma caused by terpenic compounds. According to the scoring test (organoleptic test), maceration in diethyl ether would produce *andaliman* extract with the most similar aroma compared to vacuum headspace or maceration with chloroform, ethanol or acetone (Wijaya et al., 2002).

Monoterpenes were the main compounds among the identified compounds. Geranyl acetate is the most dominant compound at the extract. This fact showed that *andaliman* volatile profile is rather different from the other *zanthoxylums* such as *Z. piperitum* DC, *Z. simulans*, and *Z. bungeanum* in which limonene is the major compound, as well as in

Rutaceae plants as *Citrus japonica* (Chyau et al, 1996, Wu et al, 1996, Nguyen et al., 1996, Trillini and Stoppini, 1994).

The aroma characteristic of *andaliman* is presented at Table 2. Sniffing analysis with AEDA indicated that citronellal (FD 128) and limonene (FD 32) have the greatest impact on fresh *andaliman* aroma. β -Myrcene, 2- β -ocimene, linalool, β -citronellal, geraniol, geranial, geranyl acetate, unknown compound, and a sesquiterpene were also contributing to *andaliman* fresh citrusy and warm sweet peppery aroma.

Table 2. The Aroma Characteristics of *Andaliman*

No.	RI (ex) ^a	RI (ex) ^b	RI (ex) ^c	Compounds	FD factors	Aroma description
1.	985	988	991	β -myrcene	8	citrus, sweet, cooked
2.	1029	1028	1021	limonene	32	orange peel, sweet
3.	1046	103+	1040	(z) β -ocimene	4	citrus, sweet, cooked
4.	1097	1102	1098	linalool	8	citrus, floral
5.	1152	1147	1153	citronellal	128	citrus, strong, warm
6.	1167			unknown	4	Green
7.	1212	1234	1228	β -citronellol	8	citrus, warm
8.	1227	1243	1240	neral	8	Lemon, sweet
9.	1256	1260	1255	geraniol	4	floral, <i>C. aurantifolia</i> leaf
10.	1274	1272	1270	geranial	8	Lemon, sweet
11.	1390	1386	1385	geranyl acetate	4	citrus, floral, acid
12.	1508	1500		a sesquiterpene	4	Woody

Note: ^aRI experiment with GC/O, column HP-5; ^bRI experiment with GC/MS, column DB-5; ^cRI reference: Adams (1995), column DB-5; ^dAroma compounds stated here is the one with FD factor ≥ 4

In addition to its exotic aroma, *andaliman* does have a unique trigeminal effect. A substituted amide (2*E*, 6*Z*, 8*E*, 10*E*-N-(2-methylpropyl)-dodecatetracnamide) has been isolated and identified as the responsible compound that 'tremble' the consumer tongues.

Jeruk purut (Indonesia), or *Kaffir limoen* (Dutch) is also included to *Rutaceae* family (Katzer, 1998). The fruit is smaller than a human fist. It shaped like pear, and having a lot of wrinkle. The peel is thick and yellowish green, the taste is very acidic, and somewhat bitter. The leaves are broadly ovate to ovate-oblong shaped, blunt edge, and having one petiole. The leaves have wide foliage. It is greenish yellow, and having fresh and delicious flavor. Instead of the fruit, *Jeruk purut* leaves is frequently utilized as herbs in various Indonesian dishes (Sarwono, 1986; Heyne, 1987; PROSEA, 1992).

Walau dari famili yang sama dan memiliki aroma dengan karakter citrus, namun flavor daun jeruk purut berbeda dengan andaliman. Aroma jeruk purut dinilai lebih ke arah harum-wangi sehingga dianggap lebih cocok sebagai fragrans. Some researches showed that citronellal is the major compound at the *jeruk purut* leaves essential oil from distillation method (Jantan et al, 1996; Muhammad Nor, 1992). Muhammad Nor (1992) mentioned that the proportion of citronellal in essential oil is 93.65%. The proportion of the citronellal in *jeruk purut* extract, however, is varied based on the extraction method (Wijaya et al., 1995).

Based on the sensory evaluation, there were no significant differences between the extracts obtained by steam or water distillation, maceration and simultaneous-extraction Likens-Nickerson. However, Likens Nickerson method would give stronger aroma compared to the other extraction methods. Likens Nickerson extract was also richer and milder compared to the distillation method (Wijaya et al, 1995).

The essential oil obtained from sliced *jeruk purut* leaves was more fresh. Meanwhile, mashing process will increase the acid number and reduce the percentage of citronellal. (Wijaya et al, 2000).

Daun lain yang sangat dikenal secara local sebagai bahan pemberi cita-rasa adalah pandan. The fragrant pandan (*Pandanus amaryllifolius* Roxb. or *Pandanus latifolius* Hassk.) can be used not only for food flavoring, but also as food colorant, room fragrance, cockroach repellent, and many others. The freshly chopped leaves are mixed with varieties of fragrant flowers to make potpourris. Fragrant pandan (*pandan wangi*) also has important roles in traditional ceremonies, such as wedding. It is also reported that *pandan wangi* is traditionally used as embrocating for rheumatic, sedative against restlessness, and to treat diabetes. The antidiabetic activity may be linked to 4-hydroxybenzoic acid which has been isolated from the root. The compound shows hypoglycemic effects in normal rats (oral administration 5 mg/kg), and increases serum insulin levels and liver glycogen content (Setyowati and J.S. Siemonsma, in de Guzman and Siemonsma, 1999).

Pandan wangi leaves have strong and delightful aroma. Their aromas are attractive to explore deeper, especially due to their potency as natural flavor sources (ingredient). Butery, et al. (1982), and Laksanalamai and Illangantileke (1993) reported that 2-acetyl-1-pyrroline produces specific aroma to pandan leaves

The aroma of *pandan wangi* leaves is not included to essential oil, but a volatile liquid. This liquid is directly evaporated from the epidermis tissue (Heyne et al., 1950). The alkyl phenols in pandan leaves is highly influenced by harvesting time and the ageing time (Wijaya et al. 2000), even though there is no synthesized new kinds of compound found during the ageing process. It was only quantitative changes observed.

Because of its capacity as good flavoring, colorant, and may be good bioactive material, it is interesting to develop it into a ready to use products, for instance, *pandan wangi* encapsulated flavor. The research to make *pandan wangi* encapsulated flavor revealed that *pandan wangi* leaves extraction by maceration process, without prior heating would produce better product compared to prior heating. Alcohol (semi polar) is a better solvent compared to hexane (non-polar) and water (polar). Ageing period for 3.8 hours would improve the flavor of the product. Based on the product's aroma and taste, the best processing method was *pandan wangi* leaves fermentation, followed by maceration in alcohol, and then followed by encapsulation process with dextrin. The fermentation process was conducted by mashing the leaves and then stored it in closed container. Meanwhile, the optimum dextrin concentration was 2% (Wijaya and Sadikin, 1993).

Some potential Fruits

Seperti halnya negara tropis yang lain, Indonesia kaya akan variasi dalam buah-buahan yang dihasilkan. Indonesia has a number of mango species (varieties). Each has different shapes and flavors. *Kweni* (*Mangifera odoranta* Griff.) is included to sweet mango groups, however it has a unique flavor. The aroma is fruity, fresh green, and slightly spicy. *Kweni* is usually consumed as a part of Indonesian desert, *rujak*, or mixed with other ingredients to make icy cocktail. This fruit is rarely served as table fruit since it may cause irritate the consumer throat and the flesh is highly fibrous (it tends to slip between the consumer's teeth). Such as it is, development of *kweni* into flavoring would widespread its utilization, and enhance its economic value.

Both of its peel and flesh has strong aroma. Based on the hedonic and multiple comparison analysis, and the aroma description evaluation, *kweni* extract obtained by maceration process would produce the most similar aroma to fresh *kweni*. Hedonic test showed that there is no significant different between the extract from *kweni* peel and *kweni* flesh, although the GC profile and the aroma notes indicated that the two of them are a slightly different (Wijaya et al, 1999).

The identification of *kweni*'s potent aroma compounds was conducted by AEDA method. The extraction was performed by dynamic headspace analysis. The aroma characteristic of *Kweni* is presented at Table 3. Ethyl butanoate that develop a sweet, fruity

and mango like aroma was identified as the important compounds in *kweni* aroma both of the peel and of the flesh.

Table 3. Odor Active Compounds in *Kweni* Headspace Extract

No.	Code	Compounds	LRlexp DB ₁ ^a	LRlexp DB ₅ ^b	LRI ref ^c	FD-factor	Description
1	A	Unidentified	600			2	Sweet, fruity, mango like
2	B	Unidentified	778	809	786 ^d	8	Sweet fruity, mango leaf like
3	C	Ethyl butanoate	792	850	826 ^d	128	Sweet, fruity, mango peel like
4	D	Ethyl crotonoate	841	935	939 ^e	32	Sweet, fruity
5	E	α -pinene	929	996	991 ^e	16	Bitter, turpentine like
6	F	β -myrcene	994			8	Bitter, metallic, young mango character.

^a LRI experiment column DB1.

^b LRI experiment column DB5.

^c Fischer et al. (1995), DB1.eAdams (1995),DB5.

Besides of its sweet and fruity notes, the two terpenes, α -pinene and myrcene seems to have important roles on the occurrence of fresh-spicy characteristic of the *kweni* flavor (Wijaya et al.). Alpha pinene is considered, as important compounds since its aroma is considerably resemble the aroma of *kweni* peel. While myrcene has been described by other researchers as herbaceous, and metallic as well as fresh and green-grassy (Gholap and Banduopadhyay, 1975; MacLeod and Pieris, 1984). In addition, ethyl crotonoate, and two unknown compounds are also important.

Buah lain yang mempunyai aroma unik dan hanya dikenal lokal oleh masyarakat khususnya pesisir utara Jawa tengah adalah Kawista (*Feromia lucida* L.) (Sarwono, 1986, MacLeod & Pieris, 1981). The ripe fruit display cooling, astringent and tonic properties, and are used as a stomachic. The fresh pulp of the ripe is mixed with sugar and eaten like sherbet, with or without the seeds.

Walau termasuk dalam is included to *Rutaceae*, aroma kawista tidak mempunyai karakter jeruk-jerukan seperti halnya andaliman atau daun jeruk purut. Aromanya juga sangat berbeda dengan *kweni*. Kawista mempunyai aroma manis dan kesan semriwing. The local people usually process it into *kawista* syrup that having unique aroma and taste (Sarwono, 1986).

MacLeod and Pieris (1981) suggested that Likens-Nickerson method is more efficient than soxhlet method in order to obtain *kawista* volatile flavor. The dominant flavor compounds of fresh *kawista* and its cream are esters such as ethyl butanoate and butanoic acid. Acetone was also identified in significant amount.

In 1998, Kumara discovered that maceration method is better than Likens Nickerson, vacuum distillation and headspace method in order to extract *kawista* flavor. The maceration process would produce extract with similar flavor to its nature. The fact is proven by scoring test (organoleptic test).

There are 75 volatile compounds identified from *kawista* fruit extract. According to AEDA technique, ethyl butyrate has the highest FD number. Meanwhile, methyl butyrate has important role on *kawista* flavor. Other compound that contributed to *kawista* flavor is 3-methyl valeric acid.

Conclusion and Suggestion

All of the materials have been studied showing great potencies as sources of unique natural flavorings. Several products could be prepared with more improvements to get ready to sell. More trials are needed to explore and to utilize other potential fruits and spices grown in Indonesia.

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