THE POTENCIES OF NATURAL FOOD ADDITIVES AS BIOACTIVE INGREDIENTS

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ABSTRACT

Food additive is one of the most important ingredients in any food products. It may improve food preference (sensory quality) of a product, extend a product's shelf life, facilitate food processing, and improve health benefits of a product. The later draws so much attention recently. A number of vitamins, minerals, amino acids, and fatty acids have been added to a food product in order to acquire extra health benefit as well as attracting the consumer to buy. As a matter of fact, there are many natural ingredients that traditionally used as food additive inherently has bioactivity that it might maintain the consumer health, cure some mild diseases, and extent the shelf life of the product. A number of researches have been conducted to study their active ingredients, their bioactivity, how to improve their stability during processing, and how to produce them in large scale. The full paper will discuss the development of research about natural food additives with bioactivity such as ginger, shallot, kluwek (*Pangium eduleReinw*), andaliman (*Zanthoxylum acanthopodium* DC), Sikam wood (*Bischoffia javanica* Bl), pandan leaves (*Pandanus Amaryllifolius*), and jeruk purut leaves (*Citrus hystrix)*

Key words: food additive, bioactive, ginger, shallot, kluwek, Pangium eduleReinw., andaliman, Zanthoxylum acanthopodium DC, Sikam wood, Bischoffia javanica Bl., pandan leaves, Pandanus Amaryllifolius, jeruk purut leaves, and Citrus hystrix.

INTRODUCTION

Development of food additive has been proceeding for centuries along with the development of food production and consumption. It runs from the ancient period, when herbs and spices was added to improve the sensory quality of plain food, and salt was added to extend the shelf life of fish to further development in food industry, when synthetic antifoam was added to facilitate food processing.

later on, development on food additive is more focussing on the comsumer's health, such as substituting natural sugar with low calorie sweeteners.

The awareness on health has been flourishing health food industry enormously. Kubomura on his report about Japanese food ingredient trends and the International Food Ingredients & Additives Exhibition and Conference 1999 mentioned that the market for health food in Japan was estimated as much as US$ 5,750 million in 1998 with an expected 4.5% increase in 1999 (Kubomura, 1999). Market research firm, Data Monitor in Prepared Foods (May 2000) predicted that the market for functional foods is expected to grow more than US$ 28 billion by the year 2003 (Prepared Foods, 2000).

Not merely conventional health foods such as milk fortified with vitamin and minerals, but extra ordinary creative health foods are also developed. Dornblaser (2002) reported that Intercontinental Brands released Nnew, i.e. a stimulating drink formulated with red and black Asian ants! The ants is claimed that it may supply a direct source of energy to body cells, enhance the immune system and improve sexual function.

Indeed, natural ingredients especially from plants are very potential for functional food additive. Many plants inherently own attractants such as colorant and flavorings to attract animals to help their reproduction stage. Most of them are also own antimicrobes and antioxidant as a part of their defense mechanism. A perfect blending of art and science would make them into delicious functional food.

Ginger

Ginger (*Zingiber officinale* Roscoe) is a traditional food additive included in Asian cuisine centuries ago. Its pungent taste and fragrant aroma makes it suitable for varieties of dishes and beverages. Ginger is also traditionally known as good medicine for influenza, nausea, and flatulency.

Ginger aroma is mainly generates by zingiberene and bisabolene, while its pungency caused by gingerols and shogaols. Modern research shows that ginger may prevent cancer (Caragay, 1992), and protect limphocyte from oxidative stress (Nurrahman, Zakaria, Sajuthi, and Sanjaya, 1999). Ginger is also proven effective to reduce chemotherapy-induced nausea (Sharma and Gupta, 1998, in IBIS 2000), and post surgery nausea (Philips et al., 1993, in IBIS, 2000).

Suekawa et al. (1984) in IBIS (2000) mentioned that ginger inhibit spontaneous motor activity, having antipyretic, and analgesic effects. The pungent compound of ginger, (6)-shogaol has better antitussive effect compared to dihydrocodeine phosphate. Ginger may reduce blood pressure as well.

As spices incorporated to fatty cuisine, ginger may inhibit platelet aggregation induced by ADP compared by control. However the serum lipid of the consumer will not altered (Verma et al., 1993 in IBIS, 2000). According to Kukuzaki and Nakatani, the antioxidative activity of ginger is higher than α-tocopherol. The aforementioned scientific facts means that ginger is very potential to be used both as food additive and functional ingredient.

Shallot

Shallot (*Allium cepa* var aggregatum) is used in most Indonesian cooking. Its sharp, pungent and savory taste becomes the symbol of Indonesian cuisine delicacy. Shallot is traditionally used to reduce fever, antihelmintic, and anti diarrhea. Shallot is also known for its ability to stimulate appetite.

Shallot flavor is a result of S-alk(en)yl Cysteine Sulfoxides (briefly called SACS) degradation. SACS are located at the cytoplasm. When the tissue is injured, CS-lyase enzyme (also known as alliinase) at the vacuole will contact with the SACS, thus producing alk(en)yl sulfenic acids (Block, et al. 1992 in Mussinan and Keelan, 1994). The typical lachrimatory factor of shallot is caused by (Z,E)-propanethial S-oxide Schmidt, et al., 1996).

Scientific exploration revealed that shallot has anti platelet aggregation (Wijaya, et al., 2000) and anti-thrombotic (Wijaya et al., 1995[a, b]) activity. Shallot may have anti carcinogenic and anti tumor activity as well, since its relative, *Allium cepa* var cepa (onion) does own the activity (Craig, 1999). Other scientists, Sheela, Kumud and Augusti (1996) reported that onion has anti diabetic effect. In 1999, Hyun and Hyang mentioned that organosulphur compounds in alliums have lipid and cholesterol lowering effects and antimicrobes. This fact is confirm by Wijaya et al. It is reported that shallot oleoresin do have lipid lowering effect.

Shallot peel mainly colored by anthocyanins. The color can simply extracted with polar solvent. Anthocyanins are claimed to be effective on inhibiting LDL-cholesterol oxidation and platelet aggregation, and it may also useful to treat vascular disorders and capillary fragility (Bruneton, 1995 in Craig, 1999).

The information revealed that shallot is potential both as natural flavorings, colorant and bioactive ingredients. However, a more comprehensive research to study its bioactivity, bioavailability and stability is definitely needed.

Kluwak

Kluwak (*Pangium edule*) seed, a black colorant and spices of some Indonesian food is known to have antioxidative activity. The levels of the antioxidant gamma-tocotrienol increased from 69.8 to 123.3 mug/g during fermentation which is traditionally conducted to eliminate the cyanogenic glucosides toxin (Nuri et al., 1999). Anwar et al. (1992) mentioned that the antioxidative component of kluwak is 1-p-hydroxyphenyl-7-aminoheptane. The methanol extract of kluwak at 0.01 % has higher antioxidant compared to BHT (Anwar, et al., 1992).

Andaliman

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). According to Hasairin (1994), *andaliman* plant may reach 3-8 meter tall. Its bark and stem are red, rough, striped, fury, and prickly. The fruits are small, round, and green. Figure 1 presents the andaliman fruit.

It is the fruit that utilized as spices. *Andaliman* fruit has fresh citrus like and warm sweet peppery aroma caused by terpenic compounds. 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 flavor is mainly consist of monoterpenes, and it is dominated by Geranyl acetate. This fact showed that *andaliman* volatile profile is rather different from the other *zanthoxylums* such as *Z. piperetum DC, Z. simulans,* and *Z. bungeaman* 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) .

Citronellal (FD 128) and limonene (FD 32) have the greatest impact on fresh *andaliman* aroma. Furthermore, β-Myrcene, 2-β-ocimene, linalool, β-citronelal, geraniol, geranial, geranyl acetate, unknown compound, and a sesquiterpenes were also contributing to *andaliman* fresh citrusy and warm sweet peppery aroma (Wijaya et al., 2001). Andaliman aroma is presented at Table 1.

Table 1. 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	12 8	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, *C. aurantifolia* leaf
10.	1274	1272	1270	geranial	8	Lemon, sweet
11.	1390	1386	1383	geranyl acetate	4	Citrus, floral, acid
12.	1508	1500		a sesquiterpene	4	Woody

Note: [a]RI experiment with GC/O, column HP-5; ;[b]RI experiment with GC/MS, column DB-5; [c]RI reference: Adams (1995), column DB-5;[d] Aroma compounds stated here is the one with FD factor ≥ 4 (Wijaya, 2001)

In addition to its exotic aroma, *andaliman* does have a unique trigeminal effect. A substituted amide (2*E*, 6Z, 8*E*, 10*E*-N- (2'methylpropyl)-dodecatetraenamide) has been isolated and identified as the responsible compound that 'tremble' the consumer tongues (Wijaya, 2000).

Andaliman raw extract is proven to have antioxidant, antimicrobial, and immunostimullant activity (Wijaya et al, 1999). Wijaya et al. research indicated that in andaliman essential oil, there are antioxidative compounds, i.e. terpenoid compounds such as geraniol, linalool, and limonene. Research with thiocyanate method indicated that andaliman extract obtained by soxhlet extraction method has higher antioxidant activity compared to α-tocopherol, but slightly lower than that of BHT.

Wijaya et al. (1999) was also conducting a research to measure andaliman antimicrobial activity. Andaliman fruit extracts were prepared by several methods, including soxhlet, maceration and water extraction. According to agar difussion test, all extraction method produce extract with antimicrobial activities against four foodborne pathogens and spoilage bacteria, namely *Pseudomonas aeruginosa, Bacillus stearothermophylus, Salmonella typhimurium,* and *Vibrio cholerae*. According to the agar well assay, freeze dried extract obtained by maceratian exhibited the highest bacteriocidal activity.

Biological assay by using human lymphocyte cells indicated that soxhlet-prepared crude extract at 4000 mg/l significantly quenched free radicals (71.90 mM) compared to that of the control (114.81 mM) on cells induced by paraquat. Soxhlet extract at this level was also able to maintain the highest number of survived cells. Free radical data produced on mice macrophage suggested that ethyl acetate-ethanol (10:1) crude extract had excellent antioxidant and immunoregulatory activities (Wijaya et al.1999).

Sikam wood

Sikam wood (*Bischoffia javanica* B.L) is traditional spice from North Sumatera. It is traditionally used for nahi nasumbah dishes made of raw pork or chicken. Sikam wood is also well known as traditional medicine for gastritis and diarrhea. Its attractive yellow color makes it appropriate for dye. Saragih et al. (1992) revealed that sikam extract has antimicrobial activity *against E. Coli, Bacillus cereus, Staphylococcus aureus, P. aeruginosa, and S. typhimurium.*

Pandan leaves

Pandan leaves (*Pandanus amaryllifolus*) can be used both as food flavoring and food colorant. As food flavoring, *pandan wangi* is frequently used to improve the flavor of non fragrant rice cultivars. It is also frequently used to flavor many different kinds of traditional porridge, jellies, and cakes. The *pandan wangi* juice is a good flavoring as well as colorant to varieties of food. *Pandan wangi* is also a good wrapper as well as flavoring for varieties of traditional dishes such as fried chicken.

Pandan wangi aroma is determined by 2-acetyl-1-pyrroline (Laksanalamai, 1993 in Jiang, 1999). Nonato et al. (1993) in Jiang (1999) identified three piperidine alkaloids in pandan leaves, they are: pandamarilactone-1, pandamarilactone 32, and pandamarilactone 31. Jiang (1999) identified 22 volatile compounds in pandan leaves. Nine of them are alcohols, 4, carboxylic acids, 3 ketones, 2 esters, 3 hydrocarbons and 1 furanone. The predominant component is 3-methyl furanone. It is accounting more than 70% total volatiles. Other major component is 3-hexanol, 4-methylpentanopl, 3-hexanone and 2-hexanone (Jiang, 1999 in Shahidi and Ho, 1999).

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

It is also reported that *pandan wangi* is traditionally used as embrocation 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 of Pandanus odorus Ridl. The compound shows hypoglycaemic effects in diabetic rats but it did not affect the serum insulin level and liver glycogen content in the diabetic model (Peungvicha et al, 1998).

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 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). Meanwhile, fermentation for 3.8 hours would improve the flavor of the product. The optimum dextrin concentration was 2% (Wijaya and Sadikin, 1993).

Jeruk purut leaves

Jeruk purut leaves (*Citrus hystrix*) is a popular flavoring in South East Asia dishes and beverages. Jeruk purut leaves essential oil is an important ingredient in the perfumery industry. The main compound of jeruk purut leaves extract is citronellal. Sato et al., (1990) identified 57 constituents in jeruk purut leaf oil. They also mentioned that 2,6-Dimethyl-5-heptenal, citronellic acid and safrole found in the various oils of citrus hystrix.

Jeruk purut is a very potential bioactive ingredients. Jamilah et al. (1998) reported that jeruk purut peel extract can retard the development of rancidity in RBD palm olein during intermittent frying of fish crackers. It means that jeruk purut may function as natural antioxidant. Knowbloch et al. (189) mentioned that citronellal has significant antibacterial properties. Meanwhile, Murakami et al. (1995) reported that jeruk purut glyceroglycolipids: 1,2-di-O-alpha-linolenoyl-3-O-beta-galactopyranosyl-sn-glycerol (DLGG) and a mixture of 2 isomers of 1-O-alpha-linolenoyl-2-O-palmitoyl-3-O-beta-galactopyranosyl-sn-glycerol (LPGG) are potencial to inhibit tumour promoter-induced Epstein-Barr virus (EBV) activation.

The proportion of the citronellal in *jeruk purut* extract, however, is varied based on the extraction method (Wijaya et al., 1995). Likens Nickerson extraction method would give stronger aroma compared to maceration and steam or water distillation. 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 fresher than mashed leaves. The height of the material in the distiilation kettle has positive correlation with the yield, but no relationship with the density, the refractive index, and the solubility index of citronellal (Wijaya et al, 2000).

CLOSING REMARK

Indonesia is rich in natural food additives that may function as bioactive ingredients as well. Unfortunately, many of our indigenous natural resources and cultural knowledge are approaching extinction. It is our duty to conserve them by conducting research and developing applicable technology to process them into ready to use products with considerable stability, bioactivity and cost.

Developing natural food additive that having bioactivity is a blend between art and science. In general there are some scientific factors need to be considered, they are:

- The native of the compound (stability, occurrence, activity, bioavailability, and toxicity).
- The native of the food product (how it is usually consumed, and who is the consumer).
- Processing technology to obtain products that possess the desired effect in considerable stability and minimum toxicity.

The next factor, which is also very important, is culinary art to make it edible, tasty and marketable. After all of the factors successfully passed, regulatory aspects and ethical aspect should be next concern.

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