Pandan leaves: “Vanilla of the East” as potential natural food ingredient

KEYWORDS: pandan leaves, natural flavour, natural colorant, traditional medicine

Abstract
Pandan leaves with the Latin name Pandanus amaryllifolius Roxb have been used in several South East Asia countries e.g. in Indonesia as a natural flavour, natural colorant and also as traditional medicine. Due to its health benefit, chlorophyll and carotenoids as main natural colorants inside pandan leaves are potential to be used in several foods. Pandan leaves also contain important aroma compounds e.g. 2-Acetyl-1-Pyrroline (ACPY) which is identified in several aromatic rice e.g. Basmati and Jasmine rice. Other class of aroma compounds e.g. nortisoprenoids also can be identified in pandan leaves e.g. β-ionone that have a good potential effect for human health. Several antioxidant compounds e.g. flavonoids, phenolic compounds, vitamin E and ascorbic acid were found in pandan leaves. These several compounds are important compounds, so that pandan leaves have been used traditionally in Indonesia for traditional medicine e.g. as anti-inflammation. This paper reviews pandan leaves as potential natural ingredients in food.

INTRODUCTION
In Indonesia, people are familiar of using several herbal leaves for special purposes especially for condiments to act as natural colorants or natural flavours to improve colour and flavours in food e.g. pandan leaves. There are several herbs that have been investigated contain expressible amounts of several bioactive compounds which can decrease ageing and also prolong life span and living organism (1). Natural products, including essential oils and extracts are the main source of biologically active compounds that can give benefit for human health (2). Pandan leaf is one of natural product which is commonly found in several South East Asia Countries (3). Many people said that pandan leaves are vanilla of the east since it is commonly used in several foods with the vanilla like aroma (4). Pandan leaves with the Latin name Pandanus amaryllifolius Roxb. are a traditional herbal leaves which have been used in cooking and also as traditional herbal treatment for several illnesses in South East Asia Countries (3). The genus name Pandanus is derived from the Indonesian name of the tree, pandan. In several Asia countries, pandan leaves, names given include pandan wangi (Malaysian), daun pandan (Indonesian), bai tyoey or toeyhom (Thai), taey (Khmer), tay ban, tyehom (Laotian), duathom (Vietnamese), and ban yan le (Chinese) [3]. The plants grow in clumps and have thin and sharp leaves at the edge where the form is like sword, fragrant odor. Pandan leaves will grow in a short shrub of 1.2-1.5 m in height and 60-90 cm in width with a stout stem and usually branched low down. The plant will not grow the flowers also. The distribution of pandan leaves is found over Southern India, the Southeast Asia peninsular, Indonesia and Western New Guinea [3]. The outline of this review is to give a review that pandan leaves are potential to be used as natural colorant, natural flavour in food and also as functional herbal medicine for human health.

PANDAN LEAVES AS NATURAL FLAVOUR
Pandan leaves, commonly known as pandan, are often used to give a refreshing, fragrant flavour to both sweet and savoury South-East-Asian dishes (rice, chicken, jellies, drinks, puddings, custard or sweets). Pandan leaves are also used in cooking ordinary non-aromatic rice to imitate the more expensive aromatic Basmati and Jasmine rice (5). Since the flavour of pandan leaves is similar to that possessed by some famous aromatic rice varieties, the leaves often find their way into the rice pot to enhance the aroma of lesser rice varieties. By increasing the aroma in lesser rice varieties, it can increase the consumer acceptance by enhance the flavour perception in customer where the non-aromatic rice has similar flavour with the aromatic rice e.g. Basmati and Jasmine rice. Flavour perception is interesting subject. The flavour of food is ultimately a product of the brain. The brain combines sensory information from taste, smell and touch to generate our perception flavour, and how it does this is currently a hot topic in psychology and neuroscience (6). The study of the mechanism of important flavour during cooking rice is quite complex, where the absorption of important flavour by rice in both optimal and excess water cooking was highly dependent on the presence of water, moisture content of rice, water to rice ratio, starch gelatinization process as well as temperature and time of cooking (7). Sometime, pandan leaves are also used to wrap food for cooking, such as chicken wrapped in pandan leaves and are neatly folded into small baskets for filling with puddings and cakes (3). The leaves are sometimes also can be put into frying oils to impart flavour to fried food e.g. French fries (5). Pandan extracts are also capable of retarding oxidation in palm olein during deep frying process than as effectively other antioxidant which is BHT (Butyl Hydroxy Toluene) (5). In sensory evaluation, the extract also was able to maintain sensory quality of French fries (5). The delightful flavour characteristic from pandan leaves, which is well-known throughout the world as an important...
component in Asian cookery, has made the industrial production of both natural extracts and artificial flavourings containing green food colours for use as food additives in Southeast Asian countries enlarge during the past two decades (3). Application of pandan leaves flavour have been used in rice, where rice-starch coating containing natural pandan extract produced non-aromatic rice with aroma compounds similar to that of aromatic rice (8). Supercritical carbon dioxide extraction from pandan leaves also have been investigated as a novel applications in food flavourings (9-10). The supercritical fluid extraction with carbondioxide gas has the potential to produce higher yield and better quality extracts of flavour than other method e.g. steam distillation and solvent extraction. Supercritical carbon dioxide extraction have more 12 new volatile compounds than steam distillation and solvent extraction. Optimum condition for the supercritical carbon dioxide extraction was obtained at pressure of 200 bar at 50°C for a contact time of 20 minutes (10). The supercritical fluid extraction also will be a potential realistic environmentally friendly technique as alternative method than the solvent extraction because is solvent less technique (10). Because it is a delightful and a sweet flavour characteristic of pandan leaves, once again it make the leaves so well-known throughout the world as an important component in Asian cookery. So that, it has made the industrial production of both natural extracts and artificial flavourings for use as a food additives in Southeast Asian countries enlarge in several decades (3). The pandan leaves have strong flavour, cheap prices and ready availability. Because of these several factors many types of artificial pandan essences are widely sold in the markets of Southeast Asian countries and replacing the fresh pandan leaves. Although the synthetic flavour have been discussed further especially in health impact effect. Nowadays, the increasing sensitivity of ecological systems will support the choice of environmentally friendly processes and consumers have developed a preference for natural ingredients (11). By legislation in US and Europe, the natural flavour substances can only be prepared either by physical processes (extraction from natural sources) or by enzymatic or microbial processes, which involve precursors isolated from nature (11). The natural ingredients have become a good positive ingredients for human health. Volatiles in pandan leaves have been investigated by using several methods where the volatile compounds in groups of alcohols, aromatics, carboxylic acids, ketones, aldehydes, esters, hydrocarbon, furans, furanones and terpenoids (3). ACPY (2-acetyl-1-pyroline) is known as important compound in pandan leaves (Figure 1). The very low odor threshold of ACPY is 0.1 nL/L has made this volatile the key impact aroma compound frequently found in several foods (3). This compounds has popcorn and roast like flavour. The formation of foods has been suggested by many researchers to occur during the food processing at elevated temperature through a reaction called Malard reaction. Amino acids can act as natural precursor of ACPY, where the proline and ornithine can act as the precursor of ACPY. By addition of these precursor the production of ACPY in pandan leaves sample will increase also (12).

Several amino acids and reducing sugar as the precursor of ACPY are explained on Table 1. Based on Table 1, fresh pandan leaves contained 2.38 mg/g fructose and 1.77 mg/g glucose. Although glucose was at lower concentration than fructose, this compound might play significant role in ACPY formation (12). Several free amino acids in fresh pandan leaves are listed in Table 1. The major free amino acid was glutamic acid (0.41 mg/g), followed by aspartic acid, threonine, serine, histidine, alanine, and proline (0.12 mg/g). In pandan leaves, it is possible that glutamic acid and proline may play an important role in pandan aroma compound formation (12). Most of ACPY in foods e.g. bread, crackers and sesame is formed by strecker degradation during the heating process (13). Naturally, the ACPY just found in pandan leaves, bread flower and aromatic rice Basmati and Jasmine rice (3). The optimum absorption of ACPY by rice during cooking was observed at 15 min of cooking time in optimal water condition (7). Beside, ACPY norisoprenoids are found as other important compounds in pandan leaves (14). This norisoprenoids are found as other important compounds in pandan leaves (14). This norisoprenoids are formed by strecker degradation during the heating process (13). Naturally, the ACPY just found in pandan leaves, bread flower and aromatic rice Basmati and Jasmine rice (3). The optimum absorption of ACPY by rice during cooking was observed at 15 min of cooking time in optimal water condition (7).

Beside, ACPY norisoprenoids are found as other important compounds in pandan leaves (14). This norisoprenoids are come from carotenoids degradation have been found in pandan leaves, so that this compounds are potential to act as aroma impact compounds in pandan leaves (14). Norisoprenoids have positive effect for human health for its anti-carcinogenic activities (15-17). β-Ionone is one of major carotenoids found in pandan leaves by HS-SPME GC-MS (Head Space Solid Phase Microextraction Gas Chromatography Mass Spectrophotometry) (14). β-Ionone is one of C-13 norisoprenoids (Figure 2). This compound can be derived from the oxidation of C9-C10 double bound or the oxidation of C9'-C10' of b-carotene as the major carotenoids in pandan leaves (14). Several processed food products and commodities commonly undergo the thermal treatment during production to increase product stability or shelf life, food safety, for easily distribution.

<table>
<thead>
<tr>
<th>Compound</th>
<th>Concentration (mg/g)</th>
</tr>
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<tbody>
<tr>
<td>Fructose</td>
<td>2.38 ± 0.01</td>
</tr>
<tr>
<td>Glucose</td>
<td>1.77 ± 0.05</td>
</tr>
<tr>
<td>Aspartic acid</td>
<td>0.21 ± 0.19</td>
</tr>
<tr>
<td>Serine</td>
<td>0.17 ± 0.04</td>
</tr>
<tr>
<td>Glutamic acid</td>
<td>0.41 ± 0.04</td>
</tr>
<tr>
<td>Glycine</td>
<td>0.05 ± 0.03</td>
</tr>
<tr>
<td>Histidine</td>
<td>0.16 ± 0.04</td>
</tr>
<tr>
<td>Arginine</td>
<td>0.02 ± 0.11</td>
</tr>
<tr>
<td>Theanine</td>
<td>0.21 ± 0.05</td>
</tr>
<tr>
<td>Alanine</td>
<td>0.16 ± 0.07</td>
</tr>
<tr>
<td>Proline</td>
<td>0.12 ± 0.04</td>
</tr>
<tr>
<td>Tyrosine</td>
<td>0.03 ± 0.06</td>
</tr>
<tr>
<td>Valine</td>
<td>0.03 ± 0.02</td>
</tr>
<tr>
<td>Lysine</td>
<td>0.03 ± 0.04</td>
</tr>
<tr>
<td>Methionine</td>
<td>0.02 ± 0.36</td>
</tr>
<tr>
<td>Leucine</td>
<td>0.02 ± 0.63</td>
</tr>
<tr>
<td>Threonine</td>
<td>0.03 ± 0.08</td>
</tr>
</tbody>
</table>

Table 1. Concentration of sugars and free amino acids (dry basis) in fresh pandan leaves (12)

Figure 1. ACPY as the important compound in pandan leaves

[11] ACPY, where the proline and ornithine can act as the precursor of ACPY. By addition of these precursor the production of ACPY in pandan leaves sample will increase also (12).

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Pandan leaves have been used traditionally in many Asian countries as food colorants. For food colorants, the leaves are usually applied into food as fresh whole leaf or juice. Pandan leaves are become popular in use as a green food colorant in pandan flavoured cakes, ice cream and custards and other Asian cuisine. Synthetic colorants are quite often applied in several products, but since the natural colorants are healthier its application of food products have to be promoted. For optimization of pandan colorants in food application, an investigation for chlorophyll extraction was performed by using enzymatic technique (21). Chlorophyll a and b have been found in pandan leaves, where the optimum extraction of chlorophyll compounds in fresh pandan leaves with 300 ppm zinc chloride at pH 5 and 110ºC for 15 minutes produced the optimal condition for Zn-chlorophyll complex formation (21).

OTHER RELATED FUNCTIONAL PROPERTIES OF PANDAN LEAVES AS FUNCTIONAL HERBAL LEAVES

As a traditional herbal this leaves are generally used for traditional medicine especially to encounter the typhus illness in Indonesia (22). The effect of antimicrobial effect of pandan leaves has been investigated on the preservation of stored milk (20). The only biomolecule isolated from fresh pandan leaves is unglycosylate protein, lectin, called pandarin. Several alkaloids such as pandaminne, pandametlanol.ons with pyrroline derived structures are also found in the leaves with is potential activity for health (23). Pandarin is a single polypeptide chain a/s molecular weight of 8 KDa and exhibits hemagglutinating activity toward rabbit erythrocytes. Pandarin also have a potential antiviral activities against human viruses e.g. herpes simplex virus type=1 (HSV-1) and influenza virus (H1N1) (23). Like other green leafy vegetables, pandan leaves are also known as potential source of several lipophilic antioxidant e.g. ß-carotene, vitamin E, phenolic compounds, ascorbic acid (24-25). Besides the lipophilic antioxidants, it also contain quercetin, alkaloids, fatty acids and ester (5). Leafy vegetables are nutrients dense sources. They possess antioxidant activity and thus have the potential to be used as cheap natural sources for reducing cellular oxidative damage and reduce degenerative conditions such as cardiovascular diseases and cancers. The consumption of several leafy vegetable are encouraged enough to fulfill nutrient especially in developing countries (26). Investigation of nutritional value of plants are essential especially to develop strategies to promote the utilization, cultivation and commercialization on these sources of nutrients which could be promoted a new source and other developing countries to assist in promoting biodiversity and combating malnutrition (26-27). Several phenolic compounds and phenolic compounds were investigated in several pandan leaves based on several geographic origin (28). Table 2 showed several concentrations of total phenolic and specific phenolic compounds in pandan leaves.

<table>
<thead>
<tr>
<th>Pandan leaves</th>
<th>in Bachok region</th>
<th>in Klang region</th>
<th>in Pontian region</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total phenolic (mg/g DW)</td>
<td>6.72 ± 0.355</td>
<td>5.07 ± 0.406</td>
<td>4.88 ± 0.477</td>
</tr>
<tr>
<td>Gallic acid (mg/g DW)</td>
<td>0.423 ± 0.052</td>
<td>0.326 ± 0.041</td>
<td>0.214 ± 0.019</td>
</tr>
<tr>
<td>Cinnamic acid (mg/g DW)</td>
<td>0.084 ± 0.033</td>
<td>0.033 ± 0.018</td>
<td>ND</td>
</tr>
<tr>
<td>Ferulic acid (mg/g DW)</td>
<td>0.281 ± 0.037</td>
<td>ND</td>
<td>ND</td>
</tr>
</tbody>
</table>

Table 2. The concentration of total phenolic and some phenolic acids detected in pandan extracts from three different locations in Malaysia (28).
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The juice extracted from the leaves mixed with Aloe vera is used to cure some skin diseases. The aromatic herbal tea of the leaves has a cardiotoxic function (3). Pandan leaves were proved to have a good activity against MCF-7 cancer line, so that pandan leaves are potential for natural aromatic herbal medicine (28). Pandan leaves have been used also not just in food but also in cosmetics as aromatic ingredient in soap, hair, and also skin care. It has been potential ingredient also to use pandan leaves as perfume ingredient. Pandan leaves have the secondary benefit of adding visual and olfactory pleasure to human since their usage as food colorants and food flavour. The fragrant leaves are often used also as a potpourri and as air fresheners.

**CONCLUSIONS**

Pandan leaves are one of example of herbal leaves with several functional properties. Mainly, pandan leaves have been used traditionally as natural flavor, natural colorants, and for treating several illnesses also. Based on the chemical compositions like antioxidant compounds inside pandan leaves, it is such promising aspect where pandan leaves can be used further for several ingredients in several food products with several potential benefits for human health.

**ACKNOWLEDGMENT**

The authors wish to thank OeAD for providing Technology Grant Scholarship and Institute of Food Science, BOKU for supporting this project.

**REFERENCES AND NOTES**


Table 3. The concentration of total flavonoid and some flavonoid compounds detected in pandan extracts from three different locations in Malaysia (28).