

## The potential of male papaya (*Carica papaya*, L.) flower as a functional ingredient for herbal tea production

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The potential of male papaya flower as a functional ingredient for herbal (green) tea production was reported by evaluating its phytochemical constituents, nutritive compositions, sensory attributes, and market potential. Phytochemical tests indicated the presence of bioactive compounds of considerable tea flavor and medical significance. Proximate composition analyses revealed significant amounts of essential dietary nutrients, some with even higher levels compared to common commercial teas, indicating that male papaya flower possesses great potential as a functional ingredient for herbal tea production that can be consumed as a dietary supplement. Despite nutritive values and potential medical benefits of male papaya flower herbal tea, its sensory evaluation scores on color, aroma and overall flavour attributes were observed lower than the two commercial teas, leading to its perceived neutral purchase intent and market potential. Nonetheless, utilization of male papaya flower as a functional ingredient for herbal tea production is recommended, but optimization of its processing procedures to improve overall attributes and consequently its market potential is necessary.

**Keywords:** Papaya, Male papaya flower, Herbal tea, Commercial tea, Phytochemicals

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Health benefits from the consumption of naturally made and plant-derived foods and food products have gained much attention. This is attributed to the fact that these foods and food products contain health-promoting nutrients and dietary phytochemicals, considered as effective tool to cure body disorders<sup>1,2</sup> and are known to cause no adverse effect to the biological system. Presently, acquisition of these health-promoting nutrients to the body system has focused on supplementation. One type of food supplement is in the form of tea<sup>3</sup>. Tea is the most widely consumed beverage in the world, after water<sup>4-8</sup>. Tea (green) is generally safe, nontoxic and has no side effects after consumption<sup>9</sup>.

Traditionally, tea has been made using the leaves, leaf buds and internodes of the tea plant [*Camellia sinensis* (L.) O. Kuntze]. Nowadays, infusion of leaves, flowers, fruits and other plant parts of herbs or plants aside from *Camellia sinensis* has been used, termed “herbal tea”. Among the plant materials being used for herbal tea production, papaya (*Carica papaya* L.) has received considerable attention due to its proven

nutritional and medical benefits. Traditionally in India, for instance, different parts of papaya, viz. fruits (ripe and unripe), seeds, bark, leaves, roots and latex has been used for treatment of several diseases like, jaundice, stomach problem, dengue, ringworm, roundworm, wound dressing, urinary complaint, anti-hemolytic activity, weight loss, high blood pressure, snake bite to remove poison and abortion<sup>10</sup>. Likewise, *Carica papaya* leaf tea or extract has a reputation as a tumour-destroying agent<sup>11</sup>. An encapsulated papaya extract has been effectively used by certain cancer patients as a botanical supplement product<sup>12</sup>. The tea, prepared with green papaya leaf, promotes digestion and aids in the treatment of ailments such as chronic indigestion, overweight and obesity, arteriosclerosis, high blood pressure, and weakening of the heart<sup>13</sup>. Additionally, the leaves of papaya have been reported to contain many active components that can increase the total antioxidant power in blood and reduce lipid peroxidation level such as papain, chymopapain, cystatin, tocopherol, ascorbic acid, flavonoids, cyanogenic glucosides and glucosinolates<sup>14,15</sup>.

In the Philippines, papaya is grown almost throughout the country as a backyard and a plantation

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crop and as a component of the multiple cropping systems because it is relatively easy to grow from seed and its fruit is produced continuously year-round. Once it starts flowering, it will continue to flower and produce fruit throughout the year<sup>16</sup>. Papaya is a fast growing, rarely branching, semi-woody tropical fruit tree with a short juvenile phase of 3-8 months. Papaya plantations in the Philippines covered 9,459 ha which produced 146,628t of fruits<sup>17</sup>.

Many researches have been conducted to evaluate the biological activities of various parts of *Carica papaya* including fruits, shoots, rinds, seeds, roots or latex. The papaya fruit, as well as all other parts of the plant, contain a milky juice known as papain which has been used to make meat tender. The unripe fruit is used as a remedy for ulcer and impotence<sup>18</sup>. Papaya leaf bark and twig tissues were found to produce natural compounds (annonaceous acetogenins) that possess both highly anti-tumour and pesticidal properties<sup>19</sup>. The high level of natural self-defence compounds in the tree makes it highly resistant to insect and disease infestation<sup>20</sup>. The seed is used for intestinal worms when chewed. The root is chewed and the juice is swallowed for cough, bronchitis, and other respiratory diseases<sup>18</sup>. Among the papaya plant parts, however, limited number of researches has been conducted on the flower.

Papaya plant come in three basic sex forms namely female, male, and hermaphrodite as expressed in the plant's flower<sup>21</sup>. The sex of a papaya plant cannot be determined by looking at the seeds or young seedlings. Papaya plants need to grow to about 2-5 feet tall before the flowers developed and the sex of the plant can be determined. In the Philippines, one common practice upon confirmation that the papaya plant is male is by eradicating and replacing them immediately, since male papaya plants have flowers without ovary and do not produce a fruit, without exploring potential applications. Male papaya trees are characterized by long, pendulous, many-flowered inflorescences bearing slender male flowers lacking a pistil, except for occasional pistil-bearing flowers at the distal terminus<sup>16</sup>. Papaya flowers are known for their appealing fragrance, one characteristic important to aromatic beverages as tea. This study evaluated the phytochemical and nutritive compositions of male papaya flower and its potential as a functional ingredient for herbal tea production.

## Methodology

### Sample collection and preparation

Male papaya flowers were obtained from occasional male plants from a farmer's backyard plantation located

in Barangay Cabuloan, Urdaneta City, Pangasinan, Philippines. Bunch of fresh male papaya flowers were collected and cleaned by removing the stalks to obtain only flowers and by washing with distilled water. Male papaya flowers were then immediately processed into herbal tea following the green tea preparation method<sup>8,22</sup>, with modifications. A portion of the fresh male papaya flowers was obtained for extraction and subsequently for phytochemical screening.

### Male papaya flower tea preparation

The technique for green tea preparation was followed. Male papaya flower tea was prepared by allowing the flowers to wilt partially (but not fermented or not oxidized). It was immediately steam-heated to inactivate inherent enzymes (polyphenol oxidase), rolled manually, and oven-dried to 4-6% moisture at relatively low temperature ( $60 \pm 5^\circ\text{C}$ ) to prevent the decomposition of heat labile bioactive compounds. With this technique, possible loss of unique aromatic compounds, development of undesirable odor and flavor attributed to the products of fermentation or enzymatic oxidation, growth of microorganisms such as fungi that could contaminate the tea with toxic and sometimes carcinogenic substances during fermentation could be prevented or minimized. Bits and pieces of male papaya flower tea (dried and crushed male papaya flowers) were packed manually in commercial tea bag cloth at 2 gm per pack of tea bag. Packed male papaya flower tea (in tea bags) were then placed in a polyethylene plastic bag, sealed to prevent volatilization of aroma, and stored at  $4^\circ\text{C}$ , until sensory evaluation. A portion of the dried male papaya flower were obtained and ground to pass 60-mesh sieve using Cyclotec® grinder (Tecator, Sweden), placed into polyethylene plastic bag and stored at  $4^\circ\text{C}$ , until proximate, beta carotene (pro-vitamin A), and mineral analyses.

### Phytochemical screening

#### Preparation of extract

Fresh male papaya flowers (about 50 gm) were cleaned, chopped, and ground using a commercial blender. Ground male papaya flowers were placed in an amber bottle, were added with 80% ethanol until completely submerged, and soaked for about 48 hrs. Afterwards, the mixture was filtered through Buchner funnel under vacuum. The filtrate was then concentrated using rotary vacuum evaporator (Eyela®, Japan) at  $40 \pm 3^\circ\text{C}$  and 70 cm Hg pressure, to obtain the concentrated extract. The extract was

then placed in an amber bottle and stored at 4°C, until phytochemical screening.

**Phytochemical screening procedure**

Qualitative phytochemical tests to determine the presence of alkaloids, leucoanthocyanins, sterols, flavonoids, saponins, triterpenoids, tannins, anthraquinone derivatives, and cardiac glycosides were carried out on male papaya flower extract according to the prescribed methods<sup>23</sup>.

**Test for alkaloids (Mayer and Wagner tests)**

The extract of male papaya flower (5 mL) was placed in an evaporating dish and evaporated to dryness or syrupy consistency under water bath. Afterwards, 10 mL of 2M HCl was added and heated in the water bath with occasional stirring. After 5 min, it was removed from the water bath and allowed to cool. About 0.5 gm of NaCl was added. The solution was then stirred and filtered using ordinary filter paper. The filtrate was dispensed in 2 mL portions into three different test tubes, one served as control. A few drops of Mayer/Wagner reagent was added to a portion of the filtrate. A white or yellowish precipitate with Mayer's reagent and brown precipitate with Wagner's reagent indicates the presence of alkaloids.

**Test for leucoanthocyanins (Bate-Smith and Metcalf tests)**

The extract of male papaya flower (5 mL) was evaporated to dryness under boiling water. Then, it was defatted by treating with hexane until the coloring was removed. Ten mL of 80% ethanol was added. The solution was then stirred and filtered using ordinary filter paper. The filtrate was dispensed in 2 mL portions into two different test tubes, one is control. About 0.5 mL of concentrated HCl was added and it was placed in a water bath at 60°C for 15 min. A strong red or violet color indicates the presence of leucoanthocyanins.

**Test for flavonoids (Sulfuric acid and sodium hydroxide tests)**

**Sulfuric acid test:** To 1 mL of the extract, 2 mL of concentrated H<sub>2</sub>SO<sub>4</sub> was added and swirled very carefully. Flavones and flavonols dissolve into concentrated H<sub>2</sub>SO<sub>4</sub> giving a deep yellow solution. Chalcones and aurones produce red or red-bluish solutions. Flavonones give orange to red color.

**Sodium hydroxide test:** The extract of male papaya flower (5mL) was placed in evaporating dish and reduced to dryness under boiling water. The residue was treated with dilute NaOH solution, followed by

addition of dilute HCl. Solubility and color changes were noted. A yellow solution with NaOH, which turns colorless with dilute HCl, confirms the presence of flavonoids.

**Test for saponins (Frothing test)**

The extract of male papaya flower (2mL) was added with 10 mL of distilled water and it was agitated in a graduated cylinder for 15 min. The formation of 1cm layer of foam showed the presence of saponins.

**Test for sterols (Salkowski reaction)**

The extract of male papaya flower (2mL) was dissolved in 2 mL of chloroform. Then, concentrated H<sub>2</sub>SO<sub>4</sub> was added, forming two phases, with a red or yellow color indicating the presence of sterols and methylated sterols.

**Test for triterpenoids (Liebermann-Burchard test)**

The extract of male papaya flower (5mL) was placed in an evaporating dish and evaporated to dryness under water bath. Then, it was defatted by treating with hexane until the coloring material was removed. Ten mL of chloroform was added, and stirred for 5 min. afterwards; it was dehydrated by filtering with anhydrous sodium sulfate over a filter paper. The filtrate was divided into two portions, one is control. Three drops of acetic anhydride and 1 drop of concentrated H<sub>2</sub>SO<sub>4</sub> was added. Formation of brown ring at the interface and greenish coloration indicates the presence of triterpenoids.

**Test for tannins (Ferric chloride and protein binding tests)**

**Ferric chloride:** The extract of male papaya flower (5 mL) was added with 3 drops of ferric chloride solution in (5% FeCl<sub>3</sub> in 95% ethanol). The formation of brown precipitate indicates the presence of tannins.

**Protein binding:** One mL of 0.5% bovine serum albumin (BSA) solution was added drop wise with the extract. A visible protein-tannin precipitate or formation of cloudiness indicates the presence of tannins.

**Test for anthraquinone derivatives (Borntrager's test)**

The extract of male papaya flower (5mL) was placed in an evaporating dish and evaporated to dryness under water bath. Ten mL of distilled water was added, mixed, and the mixture was filtered. The filtrate was then extracted with chloroform. The chloroform extract was divided into two portions, one

as control. To a portion of this extract, 1 mL of dilute (10 %) ammonia was added and the mixture was shaken. Any color change was noted. A pink-red color in the ammoniacal (lower) layer shows anthracene derivatives.

**Test for cardiac glycosides (Keller-Kiliani test)**

The extract of male papaya flower (5mL) was dissolved in 5 mL of chloroform. It was added with 2 mL acetic acid and a pinch of ferric chloride. Then, concentrated H<sub>2</sub>SO<sub>4</sub> was added slowly to form a layer and the color at interphase was noted. Brown ring at interphase and an upper green-blue color indicates the presence of cardiac glycosides.

**Physicochemical analysis and energy values**

**Proximate analysis and energy values**

Proximate compositions namely moisture content, total minerals, crude fat, crude protein, and total carbohydrates of the male papaya flower were determined according to the approved standard methods of the Association of Official Analytical Chemists. Moisture content was determined by oven-drying at 105°C until constant weight. Total minerals (ash content) were estimated by incineration of the sample at 550°C into dry ash in a muffle furnace (Heraeus Instrument GmbH, Germany). The Kjeldahl method was used for protein determination using nitrogen-to-protein conversion factor of 6.25. Crude (total) fat content was measured by extraction with petroleum ether, using a Soxhlet apparatus (Foss Tecator Soxtec System, Sweden). Total carbohydrates were determined by colorimetry using the Anthrone method. Energy values (in Kcal/gm) were obtained by multiplying the carbohydrates, protein and fat content by the Atwater conversion factors of 4, 4 and 9, respectively. Crude fat was converted into fatty acid by multiplying with a conversion factor of 0.80<sup>24</sup>.

**Mineral analysis (sodium and potassium)**

The sample from the ash content analysis was continued for mineral extraction by dry-ashing method and subsequently analyzed for sodium and potassium contents by flame photometry using Model 420 Dual Channel Flame Photometer (Sherwood Scientific Ltd, USA).

**Total carotenoid content**

Total carotenoid (as beta carotene) content of the male papaya flower was measured using colorimetric method. Briefly, 1 gm of the sample was transferred

into 15 mL centrifuge tube and was added with enough water to moisten. The samples were heated at 45°C for 10 min. Afterwards, the samples were added with 2 mL of acetone, mixed, sonicated for 30 sec, and centrifuged at 3,000 × g for 5 min. The supernatant were transferred into another 15 mL centrifuge tube. The residue was then re-extracted twice with acetone. The supernatants were combined into a centrifuge tube containing the previously collected supernatants. The tube containing the supernatants were added with 2 mL of petroleum ether, mixed, and centrifuged at 3,000 × g for 5 min. Then it was added with water to make the final volume to 14 mL. The mixtures were centrifuged at 3,000 × g for 5 min and the upper yellowish phase was transferred into 2 mL Eppendorf tube. The sample extracts were evaporated under controlled pressure using a speed vacuum apparatus (Eppendorf, San Diego, Canada). The samples were reconstituted with 1 mL of petroleum ether and the absorbance was read at 450 nm using UV-Vis spectrophotometer (Hitachi, Japan). The carotenoid content was calculated using the formula:

$$\mu\text{g/gm } \beta\text{-carotene} = \frac{\text{Abs}_{450\text{nm}} \times 1000 \times 537}{134000 \times \text{weight of sample (gm)}}$$

Where 134000 L/ (mole × cm) is ε, β-carotene and 537 gm/mole is MW β-carotene.

**Sensory evaluation**

Sensory evaluation of male papaya flower herbal tea was conducted at the Department of Food Science and Technology, College of Home Science and Industry, Central Luzon State University, Nueva Ecija, Philippines. Consumer product testing-type evaluation was carried out to assess the relative acceptance and relative attributes (color, aroma, flavor, mouth feel and aftertaste) of the male papaya flower tea using two premium commercial tea brands namely McCormick black tea (Tea A) and Lipton brisk tea (Tea B), as reference. Market potential was also included in the sensory evaluation though purchase intent rating. Fifty respondents were randomly recruited as consumer panelists.

**Sample preparation and presentation**

Fourteen gm (about 7 tea bags) of each tea (male papaya flower tea, Tea A and Tea B) was infused in 1 L of warm (70 °C) purified water for 2 min<sup>25</sup>. The

teas were individually placed in different thermos flasks to keep the temperature. About 20 mL of each sample was served to each of the panelist in Styro cups in a randomized manner with 3 digit code. Purified water and slices of cucumber were provided for each panelist as a palate cleanser. Panelists' perceptions on the tea products were gathered through a hedonic scaled sensory questionnaire.

### Statistical analysis

Sensory data were processed using Statistical Package for the Social Sciences (SPSS) version 10.0 software for windows (SPSS Inc., Chicago, Illinois, USA). Significant differences among means were detected using one way analysis of variance (ANOVA) and subsequently subjected to Duncan Multiple Range Test (DMRT) tests to compare treatment means at  $p < 0.05$  level of significance.

## Results and discussion

### Phytochemical constituents

Qualitative phytochemical tests revealed the presence of flavonoids, sterols, triterpenoids, tannins, polyphenols, and cardiac glycosides in the male papaya flower extract (Table 1). On the other hand, alkaloids, saponins, and anthraquinones were not detected using the specified assay procedure. Presence of polyphenols, flavonoids and cardiac glycosides confirmed with the previous findings on pulp and leaves of the papaya plant<sup>19,26</sup>. On the other hand, saponins and alkaloids was reportedly found on the pulp and leaves, but were not detected on the male flowers tested.

Among the phytochemicals present, tannins, polyphenols, flavonoids, and terpenoids are the most important bioactive compounds in tea of considerable

flavor<sup>22</sup> and medical<sup>27</sup> significance. Polyphenols contribute to the bitterness, astringency and sweet aftertaste of tea beverages<sup>28</sup> and are known to have powerful free-radical scavenging activity. Polyphenols such as flavonoids have anti-oxidant, anti-allergic, anti-inflammatory, anti-microbial, anti-cancer activity<sup>29,30</sup>, and antiviral<sup>31</sup> properties. The presence of some of these bioactive compounds confirmed that male papaya flower can be of medicinal importance.

Bioactive compounds that were also present namely sterols, terpenoids and cardiac glycosides are not major constituents in a tea, but they contribute to fragrances or aroma<sup>28</sup> and natural flavor of a tea. Sterols are precursor to fat-soluble vitamins and steroid hormones. As a food ingredient or additive, phytosterols have cholesterol-lowering properties<sup>32</sup>. Plant terpenoids are extensively used for their aromatic properties. They play a role in traditional herbal remedies and are under investigation for antibacterial, antineoplastic, and other pharmaceutical functions<sup>33</sup>. Terpenoids contribute to the scent of eucalyptus, the flavors of cinnamon, cloves, and ginger, and the color of yellow flowers<sup>34</sup>. Glycosides are also very important as some are cardio-active and used in treatment of heart conditions<sup>29,35</sup>. Cardiac glycosides have the ability to increase the force and power of the heart-beat without increasing the amount of oxygen needed by the heart muscle, thus can increase the efficiency of the heart and at the same time steady excess heart beats without strain to the organ<sup>36</sup>.

### Nutritive composition and energy values

Proximate analysis of the fresh male papaya flower revealed 87.7gm water, 3.7 gm crude protein, 0.4 gm crude fat, 2.0 gm total minerals (ash), 0.6 gm total carbohydrates, 569 mg potassium, 222 mg sodium, and 13.5 µg beta-carotene per 100 gm portion (Table 2). Male papaya flower was noted to have higher amounts of protein, total minerals (ash), sodium, and potassium than the literature data of green and orange-fresh papaya fruits, but not with the leaf. On the other hand, male papaya flower had the lowest level of beta carotene (pro-vitamin A) among the papaya plant parts. These nutrients and minerals are essential components of the diet. Carbohydrates is the most important source of energy (16 kJ/gm or kcal/gm); lipids, an energy source (37 kJ/gm or 9 kcal/gm triacylglycerols), is a source of essential fatty acids and vitamins; proteins is also an energy

Table 1—Phytochemical constituents of the male papaya flower

Phytochemical constituent	Result*
Alkaloids with Mayer's reagent and Wagner's reagent	-
Leucoanthocyanins by Bate-Smith and Metcalf test	-
Flavonoids using sulfuric acid and sodium hydroxide test	+
Saponins by frothing test	-
Sterols with Salkowski reaction	+
Triterpenoids by Liebermann-Burchard test	+
Polyphenols by ferric-to-ferrous reduction	+
Tannins by protein binding	+
Anthraquinone derivatives with Borntrager's reagent	-
Cardiac glycosides with Keller Kiliani reagent	+

\*Legend: +, constituent present; -, constituent not detected

Table 2—Nutritive composition of male papaya flower and other papaya plant parts

Nutrient	Value per 100 gm (Fresh basis)			
	Male flower*	Green fruit <sup>25,34,37,38</sup>	Orange-Fresh fruit <sup>25,37</sup>	Leaves <sup>38</sup>
Proximates				
Water	87.7± 0.0 gm	92.1 gm	88.8 gm	77.5 gm
Protein	3.7 ± 0.0 gm	0.7-1.0 gm	0.61 gm	7.0 gm
Total lipid (fat)	0.4 ± 0.0 gm	0.1-0.2 gm	0.1-0.14 gm	2.0 gm
Ash (total minerals)	2.0 ± 0.0 gm	0.5-0.6 gm	0.5-0.61 gm	2.2 gm
Total Carbohydrates	0.6 ± 0.1 gm	5.7-6.2 gm	7.2-9.81 gm	11.3 gm
Minerals				
Potassium, K	569 ± 32 mg	233 mg	257 mg	652 mg
Sodium, Na	222 ± 7 mg	4 mg	3 mg	16 mg
Other				
Beta-carotene (pro-vitamin A)	13.5 ± 0.8 µg	800 µg	232.3 µg	11565 µg

\*Values are mean ± SD of two replicates.

Table 3—Nutritional information of male papaya flower tea

Nutrient	Per 100 gm		Per serving (2 gm serving size)	
	Value	Energy value (Kcal)	Value	Energy value (Kcal)
Proximates				
Water	6.0 gm	n.a.	120 mg	n.a.
Protein	28.1 gm	112.4	561 mg	0.48
Total lipid (fat)	3.4 gm	24.5	67 mg	0.48
Ash (Total minerals)	15.6 gm	n.a.	312 mg	n.a.
Total Carbohydrates	3.4 gm	13.6	96 mg	0.38
Minerals				
Potassium, K	4.3 gm	n.a.	85 mg	n.a.
Sodium, Na	1.7 gm	n.a.	35 mg	n.a.
Others				
Carotene, beta	102.9 µg	n.a.	2 µg	n.a.
Total Energy Value (from protein, fat and carbohydrates)	n.a.	150.5 Kcal	n.a.	1.35 Kcal

Legend: n.a. - Not applicable

source with nutritional value energy (17 kJ/gm or kcal/gm) as high as that of carbohydrates; vitamins are required for normal growth, maintenance and functioning of the body and; minerals such as potassium and sodium are involved in the bioavailability of different nutrients<sup>37</sup>.

Nutritional composition of male papaya flower tea (at 6 % moisture) expressed per 2 gm serving size revealed 561 mg protein, 67 mg total lipids, 312 mg total minerals, 96 mg carbohydrates, 85 mg potassium, 35 mg sodium, and 2.0 µg of beta-carotene (pro-vitamin A) (Table 3). Corresponding total energy value (calculated from protein, fat and carbohydrates contents) was 150.5 Kcal/gm per 100 gm of male papaya flower tea, while 1.35 Kcal for a single

serving (per 2 gm tea bag). Recommended daily intakes for ages beyond 13 yrs old for protein, carbohydrates, sodium, potassium and vitamin A are 34-56 gm, 130 gm, 1-1.5 gm, 3-4.7 gm and 600-900 µg, respectively<sup>40</sup>. This translate a contribution of a single serving of male papaya flower tea of about 1.7 % protein, 0.1% carbohydrates, 3.5 % sodium, 2.8 % potassium, and 0.02 % vitamin A to the daily nutrient requirements of the body. More consumption of male papaya flower tea offer more nutrients and healthful bioactive compounds. In this sense, male papaya flower tea can be consumed as a dietary supplement.

Higher levels of protein (28.1 gm), potassium (4.3 gm), and sodium (1.7 gm) of male papaya flower tea were noted compared to the literature data of

Table 4—Product attribute liking of male papaya flower tea

Attribute	Mean score*		
	Male Papaya Flower Tea	Tea A	Tea B
Color	4.17 <sup>b</sup>	5.90 <sup>a</sup>	5.62 <sup>a</sup>
Aroma	3.10 <sup>b</sup>	6.12 <sup>a</sup>	6.16 <sup>a</sup>
Overall flavor	3.67 <sup>b</sup>	5.16 <sup>a</sup>	4.68 <sup>a</sup>
Mouth feel	4.06 <sup>b</sup>	5.14 <sup>a</sup>	4.80 <sup>ab</sup>
Aftertaste	3.86 <sup>a</sup>	4.67 <sup>a</sup>	4.58 <sup>a</sup>

Means within a row with same letters are not significantly different ( $\alpha=0.05$ )

\*1=don't like at all; 5= neutral; 9= like it a lot

commercially available teas<sup>41-44</sup>. This may indicate that male papaya flower may have nutritional advantage as a plant material for tea production. These plant nutrients and valuable metabolic co-factors (minerals) play a critical role in homeostasis and regulatory and transport systems in the body. Total lipid content (3.4 gm) fall under the typical tea composition levels (3-5 gm). On the other hand, significant lower amount of total carbohydrates of male papaya flower tea at 3.4 gm compared to common commercial teas (65.3 gm) was noted, but this may be appealing particularly to diabetic and health conscious individuals. Numerous studies reported that high carbohydrate consumption is related to weight gain leading to the increase in vulnerability to cardiovascular diseases. Beta-carotene (pro-vitamin A) was not found on commercially available teas.

#### Sensory evaluation

##### *Product attributes liking and perception*

Product liking on color, aroma, overall flavor, mouth-feel, and after taste attributes of the male papaya flower tea and the commercial teas was shown in Table 4. Statistical analysis revealed that after-taste attribute of the male papaya flower tea is comparable with the two commercial teas. Likewise, mouth feel score of male papaya flower tea (4.06) was perceived similarly to that of tea B (4.80). On the other hand, color, aroma, and overall flavor of male papaya flower tea yielded significantly lower attribute scores from the panelists compared to the two commercial brands.

Individual product attributes perception signifying if their specific intensity is “just right” or too little/ too intense is shown in Table 5. Results revealed that consumers' perception on mouth feel and aroma attributes of male papaya flower tea was comparable with the two commercial teas. Likewise, overall

Table 5—Product attributes perception

Attribute	Mean score		
	Male Papaya Flower Tea	Tea A	Tea B
Color*	1.81 <sup>b</sup>	2.98 <sup>a</sup>	3.42 <sup>a</sup>
Aroma**	2.71 <sup>ab</sup>	2.96 <sup>a</sup>	2.71 <sup>b</sup>
Overall flavor***	2.77 <sup>b</sup>	3.12 <sup>ab</sup>	3.27 <sup>a</sup>
Mouth feel****	2.59 <sup>a</sup>	2.96 <sup>a</sup>	2.60 <sup>a</sup>
After taste***	2.53 <sup>b</sup>	3.08 <sup>a</sup>	3.24 <sup>a</sup>

Means within a row with same letters are not significantly different ( $\alpha=0.05$ )

\*1= Much too light; 3= Just right; 5= Much too dark

\*\*1= Much too strong; 3= Just right; 5= Much too weak

\*\*\*1= Much too weak; 3= Just right; 5= Much too strong

\*\*\*\*1= Much too astringent; 3= Just right; 5= Not astringent at all

flavor of the male papaya flower tea was perceived to be similar with the commercial tea A which is comparable with tea B. However, color and after taste attribute consumers' perception of male papaya flower tea was significantly lower than the two commercial teas.

Fig. 1 shows the percentage of respondents indicating that the specific attribute intensity is “just right” or too little/ too intense. Male papaya flower tea was perceived to have lower attribute perception rating score than the two commercial teas. Majority of the respondents perceived the male papaya flower tea to have too light color, and too little aroma, flavor, mouth feel and aftertaste. Low attribute rating scores of male papaya flower tea agreed to evident too little color, aroma and flavor as perceived by the panelists. Likewise, its ‘just about right’ score is lower than the two commercial teas.

Overall product liking as indicated by percentages of respondents that like or dislike the product is shown in Fig. 2. Male papaya flower obtained a significantly lower overall product liking with a mean score of 4.02 relative to the two commercial teas (tea A=5.28 and tea B=5.68). Majority of respondents (21) neither like nor dislike (neutral) the male papaya flower tea.

##### *Market potential*

The potential of male papaya flower tea for commercialization was evaluated in reference to the two commercially available teas through buying intent perception assessment. Statistical analysis revealed that male papaya flower tea had significantly lower purchase intent score with a mean value of 2.42 compared with the two commercial teas. This could be attributed to its low attribute rating levels and

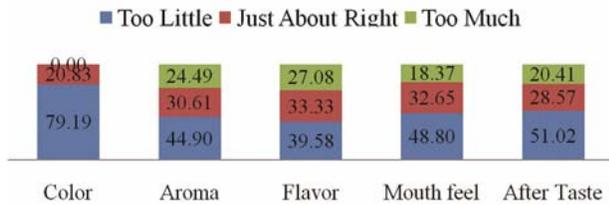


Fig. 1—Attributes perception of male papaya flower tea (N=50)

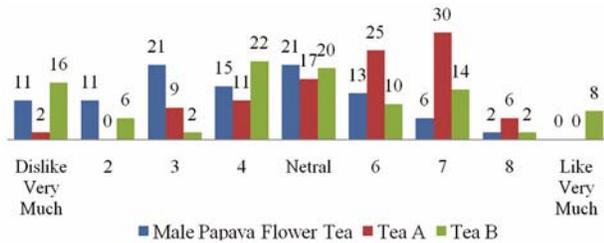


Fig. 2—Overall product liking of male papaya flower tea and teas A and B (N=50)

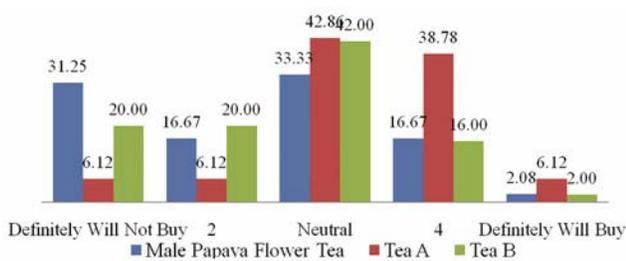


Fig. 3—Overall purchase intent of male papaya flower tea and teas A and B (N=50)

perceptions on aroma, color, and overall flavor as perceived by the panelists. When the respondents were asked whether they will buy the product, majority of them are undecided (Fig. 3). This means that there is a wide possibility that when the product is enhanced in terms of aroma, color, and overall flavor, its buying potential can possibly increase.

## Conclusion

Significant amounts of bioactive compounds and essential dietary nutrients noted on male papaya flower indicated its great potential as a functional ingredient for herbal tea production that can be consumed as a dietary supplement. Despite nutritive values and potential medical benefits of male papaya flower herbal tea, lower attribute and perception scores on color, aroma and overall flavour compared to commercial teas were observed leading to its neutral purchase intent and market potential. Utilization of male papaya flower as a functional ingredient for herbal tea production is recommended, but optimization of its processing procedures to

improve overall attributes and consequently its market potential is necessary.

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## References

- Raskin I, Ribnicky DM, Komamytsky S, Ilic N & Fridlender B, Plants and human health in the twenty-first century, *Trends Biotechnol*, 20 (2002) 522-531.
- Rates SM K, Plants as source of drugs, *Toxicol Res*, 60 (2001) 6465-6471.
- [USDA] United States Department of Agriculture, Special Focus—Green Tea, <http://www.usada.org/uploads/supconfusion.pdf> Accessed: 05/01/2014
- Cabrera C, Artacho R & Gimenez R, Beneficial effects of green tea—a review, *J Am Coll Nutr*, 25 (2006) 79-99.
- Cabrera C, Nez RG & Loä Pez MC, Determination of Tea Components with Antioxidant Activity, *J Agric Food Chem*, 51 (2003) 4427-4435.
- Sharma VK, Bhattacharya A, Kumar A & Sharma HK, Health Benefits of Tea Consumption, *Trop J Pharm Res*, 6 (3) (2007) 785-792.
- Sharangi AB, Medicinal and therapeutic potentialities of tea (*Camellia sinensis*, L.) – A review, *Food Res Int*, 42 (2009) 529-535.
- Wang Y & Ho C-T, Polyphenolic Chemistry of Tea and Coffee: A Century of Progress, *J Agric Food Chem*, 57 (2009) 8109-8114.
- Erturk Y, Ercisli S & Tosun M, Physico-chemical characteristics of wild plum fruits (*Prunus spinosa* L.), *Int J Plant Prod*, 3 (2009) 89-92.
- Saran PL, Choudhary R, Solanki IS & Devi G, Traditional medicants through papaya in North eastern plains zone of India, *Indian J Tradit Knowle*, 15 (4) (2015) 537-543.
- Walter Last Cancer remedies, 2008, <http://www.health-science-spirit.com/cancer6-remedies> Accessed: 05/09/2013.
- McLaughlin JL, Paw Paw & Cancer: Annonaceous Acetogenins from Discovery to Commercial Products, *J Nat Prod*, 71 (7) (2008).
- Mantok C, Multiple usage of green papaya in healing at Tao Garden. Tao Garden health spa and resort, Thailand, 2005 <http://www.tao.graden.com> Accessed: 05/01/2014.
- Otsuki N, Dang NH, Kumagai E, Kondo A, Iwata S & Morimoto C, Aqueous extract of *Carica papaya* leaves exhibits anti-tumor activity and immunomodulatory effects, *J Ethnopharmacol*, 127 (2010) 760-767.
- Seigler DS, Pauli GF, Nahrstedt A & Leen R, Cyanogenic allosides and glucosides from *Passiflora edulis* and *Carica papaya*, *Phytochemistry*, 60 (2002) 873-882.

- 16 Minga R, Yu b Q & Moorec PH, Sex determination in papaya, *Seminars in Cell and Developmental Biology*, 18 (2007) 401–408.
- 17 [PCARRD-DOST] Philippine Council for Agriculture, Forestry and Natural Resources Research and Development – Department of Science and Technology, 2005 [http://www.pcaarrd.dost.gov.ph/home/joomla/index.php?option=com\\_content&task=view&id=596&Itemid=465](http://www.pcaarrd.dost.gov.ph/home/joomla/index.php?option=com_content&task=view&id=596&Itemid=465) Accessed: 05/01/2014.
- 18 Aiyeloja A & Bello OA, Ethnobotanical potentials of common herbs in Nigeria: A case study of Enugu state, *Rev Educ Res*, 1 (1) (2006) 16-22.
- 19 Ayoola PB & Adeyeye A, Phytochemical and nutrient evaluation of carica papaya (pawpaw) leaves, *Int J Res Rev Appl Sci*, 5 (3) (2010) 325-328.
- 20 Mattsson JL, Mixtures in the real world: The importance of plant self-defence toxicants, Micotoxins and the human diet, *Toxicol Appl Pharm*, 223 (2007)125-132.
- 21 Teixeira da Silva JA, Rashid Z, Nhut DT, Sivakumar D, Gera A, Teixeira Souza MJ & Tennant PF, Papaya (*Carica papaya* L.) Biology and Biotechnology, (Tree and Forestry Science and Biotechnology, Global Science Books), 2007, 53.
- 22 Harbowy ME & Balentine DA, Tea Chemistry, *Crit Rev Plant Sci*, 16 (5) (1997) 415-480.
- 23 Trease GE & Evans WC, Pharmacognosy, 14th edition (WB Saunders Company Ltd. UK), 1996, 1098-1115.
- 24 Greenfield H & Southgate DAT, Food composition data: Production, management and use, (Food and Agriculture Organization of the United Nations, Rome, Italy), 2003, 288.
- 25 Lee MS, Kim CT, Kim IH & Kim Y, Inhibitory effects of green tea catechin on the lipid accumulation in 3T3-L1 adipocytes, *Phytother Res*, 23 (2009)1088–1091.
- 26 Khrishna KL, Pandhavi M & Patel JA, Review on nutritional, medicinal and pharmacological properties of papaya (*Carica papaya*, L.), *Nat Prod Rad*, 7(4) (2008) 364-373.
- 27 Lister E & Wilson P, Measurement of total phenolics and ABTS assay for antioxidant activity (Personal Communication), Lincoln, New Zealand, *Crop Res Inst*, 2001.
- 28 Hara Y, Luo SJ, Wickremashinghe RL & Yamanishi T, Processing tea, *Food Rev Int*, 11 (1995) 409-434.
- 29 Trease GE & Evans WE, Pharmacognosy, 15th edition (W. B. Saunders Company Limited, London), 2002, 585.
- 30 Kunle OF & Egharevba HO, Preliminary studies on Vernonia ambigua: Phytochemistry and antimicrobial screening of whole plant, *Ethnobot Leaflets*, 13 (2009)1216-1221.
- 31 Elumalai EK, Ramachandran M, Thirumalai T & Vinothkumar P, Antibacterial activity of various leaf extracts of Merremia emarginata, *Asian Pac J Trop Biomed*, 1 (5) (2011), 406-408.
- 32 Hicks KB & Moreau RA, Phytosterols and phytostanols: Functional food cholesterol busters, *Food Technol*, 55 (2001) 63-67.
- 33 Ponnusamy S, Gnanaraj WE & Antonisamy JM, Terpenoids Profile of Clitoria Ternatea Linn, *J Harmonized Res Pharm*, 2(2) (2013) 104-111.
- 34 Yermakov AI, Khlaifat AL, Qutob H, Abramovich RA & Khomyakov YY, Characteristics Of The GC-MS Mass Spectra Of Terpenoids (C<sub>10</sub>H<sub>16</sub>), *Chem Sci J*, 7 (2010) 1-10.
- 35 Oloyode OI, Chemical profile of unripe pulp of Carica papaya, *Pak J Nutr*, 4(6) (2005) 379-381.
- 36 Stray F, The natural guide to medicinal herbs and plants (Tiger Books International, London), 1998, 12-16.
- 37 Belitz H-D, Grosch W & Schieberle P, Food Chemistry, 4<sup>th</sup> Revised and extended edition (Springer-Verlag Berlin Heidelberg, Germany. e-ISBN 978-3-540-69934-7), 2009.
- 38 Duke JA, Handbook of Energy Crops (unpublished), *Carica papaya* L. [http://www.hort.purdue.edu/newcrop/duke\\_energy/Carica\\_papaya.html](http://www.hort.purdue.edu/newcrop/duke_energy/Carica_papaya.html) Accessed: 05/01/2014.
- 39 [USDA] United States Department of Agriculture, Nutrient Database for Standard Reference, Release 18, 2005 <http://www.nal.usda.gov/fnic/foodcomp/search/> Accessed: 05/01/2014.
- 40 National Academy of Sciences, Food and Nutrition Board 2002. Dietary Intake <http://iom.edu/en/Global/News%20Announcements/~media/Files/Activity%20Files/Nutrition/DRIs/DRISummaryListing2.ashx> Accessed: 05/01/2014.
- 41 Akande IS, Samuel TA, Agbazuela U & Olowolagba BL, Comparative Proximate Analysis of Ethanolic and Water Extracts of Cymbopogon citratus (Lemon grass) and Four Tea Brands, *J Pharm Biomed Sci*, 22(22) (2001).
- 42 Imran A, Butt MS, Yasin M, Imran M, Batool R & Naz A, Phytochemical screening of different black tea brands, *Int J Food Safety*, 13 (2011) 226-231.
- 43 Mishra J, Dash AK & Dash DK, Medicinal and Therapeutic Potentialities of GreenTea (Camellia Sinensis)-A Review, *World J Pharm Pharm Sci*, 2 (6) (2013) 4745-4763.
- 44 Chemistry of Tea <http://www.upasitearesearch.org/chemistry-of-tea/> Accessed: 05/01/2014.