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Determination of the content of major chemical components and bioactive compounds and antioxidant ability of Hong Quan (*Flacourtia jangomas* (Lour.) Raeusch) fruit cultivated in An Giang, Vietnam

Nguyen Duy Tan[1,3]*, Vo Thi Xuan Tuyen[2,3] & Tran Nghia Khang[1,3]

[1]Department of Food Technology, Faculty of Agriculture and Natural Resources, An Giang University, Long Xuyen City, An Giang Province 880000, Vietnam
[2]Department of Crop Science, Faculty of Agriculture and Natural Resources, An Giang University, Long Xuyen City, An Giang Province 880000, Vietnam
[3] Vietnam National University Ho Chi Minh City (VNU-HCM), Linh Trung Ward, Thu Duc City, Ho Chi Minh City 700000, Vietnam

*Email: ndtan@agu.edu.vn

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Abstract

Hong Quan (*Flacourtia jangomas* (Lour.) Raeusch) is a new fruit that has appeared recently and it is cultivated with other orchards or under forest canopy of Tri Ton and Tinh Bien district at An Giang province. Since this fruit has not been popularized in Vietnam, there is a shortage in research about chemical compositions of Hong Quan. Therefore, quantitative analysis of main chemical components, bioactive compounds and antioxidant activity of this kind of fruit need to be carried out to enhance its applications in food. Results showed that Hong Quan fruits contain 76.50% ± 2.56 of moisture, carbohydrate is 24.86% ± 1.54, protein is 9.19% ± 0.49, lipid is 0.68% ± 0.21, total sugar is 10,91% ± 0.88, ash is 1.05% ± 0.08, fiber is 8.39% ± 0.95 and vitamin C is 81.62 ± 3.99 mg/100g. The content of bioactive compounds such as carotenoids, phenolics, tannins, alkaloids, saponins and flavonoids were 9.87 ± 0.40 mg/100g, 456.32 ± 23.81 mgGAE/100g, 944.08 ± 26.31 mgTAE/100g, 586.68 ± 44.56 mgCE/100g, 20.87 ± 2.00 mgSE/100g and 65.95 ± 2.92 mgQE/100g fresh weight respectively. Moreover, antioxidant capacity of extract ethanol from fruit was high level as the free radical scavenging ability (DPPH) at 88.65% ± 1.23, the ability to reduce iron (FRAP) at 15.24 ± 0.26 mM $FeSO_4$/100g and the antioxidant ability index (AAI) at 8.13 ± 0.82. Hong Quan fruit promisingly could be a good source of commercial processing products or cosmetic due to high level of nutrients and functional compounds.

Keywords

Flacourtia jangomas fruit; chemical components; bioactive compounds; antioxidant activity

Introduction

Fruits and vegetables possess a various range of micronutrients and bioactive compounds such as dietary fiber, minerals, vitamins and phytochemicals. Approximately there are more than 5000 different phytochemicals have been found in fruits, vegetables but lots of them remains unknown (1). Bioactive could include pharmacological ability and/or poisonous ability with human. They generate important functions in the living cell such as protection against free radicals and prevention of disease (2). People who

eat more fruits and vegetables as part of a healthy diet are likely to have a reduced risk of heart disease, including heart attack and stroke and certain types of cancers (3).

Flacourtia jangomas (Hong Quan) is a plant of the willow family. It is distributed throughout the tropics including East Africa and Asia, and known for its medicinal and culinary uses (4). This is a semi-cultivated fruit plant and has some medicinal as well as economic values. It is mainly cultivated for its edible fruit and hard wood. The fruits are dark red or purple when ripe and eaten raw or used for making jams and preserves. The other plant parts are also used for the treatment of asthma, blood purification and diarrhea (5). The fruit is round with a size of about 18-23 mm, when ripe, it is brownish purple in color and sweet taste (6).

In An Giang, Hong Quan has fruit once a year around August and September. The fruits have a pleasant sweet and sour taste. It is mainly used to eat fresh or soak in spirt. Currently, Hong Quan fruits are collected and distributed to Ho Chi Minh City and other provinces in the Mekong Delta. Depending on the time of harvest season it has different prices, usually at the beginning or the end of the season the price is high but in the main harvest the price drops ranging from 20000-50000 VND/kg. This is also a source of income for poor households in 2 mountainous districts (Tri Ton and Tinh Bien) of An Giang province. However, so far in Vietnam Hong Quan studies has not been published especially on the chemical compositions, so researching chemical components as well as antioxidant ability of Hong Quan fruit cultivated in An Giang has been carried out. The Data may help to promote this fruit to domestic and foreign consumers as well as industrial partners.

Materials and Methods

Sample collection

Ripe Hong Quan fruits were collected from the growing area at Tinh Bien district (latitude: 10° 34' 58.80" N, longitude: 105° 00' 0.00" E), An Giang province (Fig. 1) . The fruit were taken to the laboratory, washed, let naturally dry, divided into 1 kg weight for each plastic bag (PE) and stored in the freezer (Inverter Sanaky 761 Litre VH 8699HY3) at temperature ≤ -18 °C. Materials are ready for experimental analysis of chemical components, bioactive compounds and antioxidant ability.

Determination of the chemical compositions

The lipid content was determined by the Soxhlet method of extraction using petroleum ether. The moisture content was determined by measuring the weight loss after drying (7). The content of crude fiber, total ash and total sugar in the Hong Quan fruit were estimated according to the methods described (8). The protein content was determined by Folin-Ciocalteu reagent method described (9). The carbohydrate content was determined following the standard method described (10). All results were reported as percent (%).

Preparation of Hong Quan extract for analysis of bioactive compounds and antioxidant ability

Hong Quan fruits were ground and extracted with ethanol 60% v/v, for 60 min at a 1:20 (w/v) of material:solvent ratio.

Determination of phenolic content

The phenolic content was determined by Folin-Ciocalteu reagent method described (11), result was calculated according to calibration curve of gallic acid ($y = 0.0082x + 0.0595$, $r^2 = 0.9996$) and expressed as mg of gallic acid equivalents (mg GAE)/100 g of (FW).

Determination of flavonoid content

The aluminum chloride colorimetric method was used for flavonoids determination following the standard description (12), the calibration curve was prepared ($y = 0.0054x + 0.0026$, $r^2 = 0.9995$), the content of flavonoid was calculated as mg of quercetin equivalent (mg QE) per 100 g of FW.

Determination of tannin content

Tannin content was determined by Folin-Denis method (13) and based on the calibration curve of tannic acid ($y = 0.0098x + 0.0478$, $r^2 = 0.9996$), result was expressed as mg of tannic acid equivalents (mg TAE) per 100 g of FW.

Determination of saponin content

Saponin content was evaluated by colorimetric method (14) and result was expressed as mg saponin equivalent (mg SE) per 100 g of FW.

Determination of alkaloid content

Alkaloid content was determined by colorimetric method described (15), result was calculated following calibration curve of colchicine ($y=0.0035x + 0.7552$, $r^2= 0.9983$) and expressed as mg colchicine equivalent (mg CE) per 100 g of FW.

Fig. 1. Hong Quan fruits in Tinh Bien, An Giang, Vietnam

Determination of vitamin C content

Vitamin C was estimated according to method described (9), content of Vitamin C was expressed as mg per 100 g of FW.

Determination of carotenoids content

The content of carotenoids was measured according to colorimetric method described (16).

Determination of ferrous reduction ability power (FRAP)

Iron reduction capacity was measured by FRAP method (17). The results are calculated against the $FeSO_4.7H_2O$ standard curve (y = 0.5177x + 0.0855, r^2 = 0.9981), and expressed as millimol ferric sulfate (mM $FeSO_4$) per 100 g of FW.

Determination of DPPH (2,2-diphenyl-1-picrylhydrazyl) scavenging activity

DPPH free radical scavenging capacity was determined according to the method (18), DPPH (%) = [(Abs control – Abs sample)/Abs control] x 100, where, Abs control is the absorbance of DPPH solution mixed in ethanol, Abs sample is the absorbance of extracts + DPPH solution.

Determination of antioxidant ability index (AAI)

AAI was determined by the method of total reduction capacity described (19), the results were calculated according to the formula (AAI = Abs sample/Abs control, with Abs sample: absorbance of the sample and Abs control: absorbance of the control sample).

Statistical analysis

All data were replicated in at least 6 independent experiments. The results are reported as the mean ± standard deviation.

Results and discussion

Chemical composition in Hong Quan fruit

The study on the nutritional properties of food has received much notice because of its relevance in the finding of functional foods. Fruit has been known as one of the most valuable sources of nutrients due to the presence of bioactive compounds (5). Macronutrients are the nutrients that the human body needs in large amounts, which include fat, carbohydrate and protein. The macronutrients provide energy, and it contains the components of food that the body needs to maintain its systems and structures (20). The present study result showed that Hong Quan fruit collected from Tinh Bien district, An Giang province presented carbohydrate, total sugar, total protein, total lipid, fiber, ash and vitamin C (Table 1).

According to one report (21), *F. Jangomas* fruit was moisture 68%, ash 1.01 g, carbohydrate 23.44 g, fiber 4.02 g, protein 3.18 g, total sugar 6.18 g and acid ascorbic 26.74 mg per 100g of fresh weight. Another result showed that chemical components of *F. jangomas* include carbohydrate 21 g, protein 3.9 g, vitamin C 218 mg/100g dry weight (22). In addition, it was also reported *F. jangomas* fruits get presence of ash 1.20 g, moisture 65.27%, crude fat 4.09 g, crude fibre 9.85 g, protein 7.39 g and carbohyrate 77.48, based on dry matter (23). It was showed that *F. jangomas* fruits contained carbohydrate 14.1 g, total protein 4.21 g, total lipid 0.16 g, crude fibre 1.01 g, ash 0.74 g, ascorbic acid 105.63 mg/100g of dry matter (24). Whereas the present study finds the content of carbohyrate in a similar amount (21, 22) at 24.86 g and it was higher than the earlier report, but lower than another result (23, 24). The content of total sugar was 10.91 g and it was higher (21). The content of total protein, total lipid, crude fiber and ash were 9.19 g, 0.68 g, 8.39 g and 1.05 g/100 g of fresh weight respectively. Other studies reported the amount of total protein range from 3.19 g to 7.39 g, total lipid from 0.16 g to 4.09 g, crude fiber from 0.01 g to 9.85 g and ash from 0.735 g to 1.20 g of fresh weight. The content of vitamin C was 81.62 mg/100g of fresh weight. However, result of other studies reported to be 105.63 mg, 218 mg (per 100 g of dry weight) and 27.74 mg/100 g of fresh weight. The moisture content of Hong Quan was 76.5%, while other reports were 68% and 65.27% (21, 23). The differences in chemical components could cause by geographical locations and the cultivating methods but they are still in ranges of early researches. In short, Hong Quan fruit is a juicy sweet fruit, high in fiber, protein and vitamin C. Hong Quan fruit promisingly could gain many attentions from consumers as a new fresh fruit on fruit market.

Table 1. Content of nutrients compositions in Hong Quan fruit

No.	Compounds	Results(Mean ± SD, n = 6)
1	Carbohydrate (%)	24.86 ± 1.54
2	Total sugar (%)	10,91 ± 0.88
3	Total protein (%)	9.19 ± 0.49
4	Total lipid (%)	0.68 ± 0.21
5	Crude fiber (%)	8.39 ± 0.95
6	Ash (%)	1.05 ± 0.08
7	Moisture (%)	76.50 ± 2.56
8	Vitamin C (mg/100g FW)	81.62 ± 3.99

Bioactive compounds in Hong Quan fruit

It was reported that *F. jangomas* fruit contains anthocyanin, alkaloids, β-carotene, flavonoids, tannins, saponins and phenolic compounds (4). They are considered as good antioxidants and have good reducing power. The present study also determined the composition of bioactive compounds in Hong Quan fruit including flavonoids, tannins, phenolics, saponins, alkaloids and carotenoids (Table 2).

Data showed that phenolics and flavonoids in Hong

Table 2. Content of bioactive compounds in Hong Quan fruit

No.	Compounds	Results (Mean ± SD, n = 6)
1	Flavonoids (mg QE/100g FW)	65.95 ± 2.92
2	Tannins (mg TAE/100g FW)	944.08 ± 26.31
3	Phenolics (mg GAE/100g FW)	456.32 ± 23.81
4	Saponins (mg SE/100g FW)	20.87 ± 2.00
5	Alkaloids (mg CE/100g FW)	586.68 ± 44.56
6	Carotenoids (mg/100g FW)	9.87 ± 0.40

Quan were 456.32 mg GAE/100g and 65.95 mg QE/100 g of fresh weight, they were higher than observed results (24) which were 390 mg GAE/100 g and 6.66 mg QE/100 g of dry matter respectively. However, the former studies found phenolic content at a very high amount at 2507.41 mg GAE/100 g for the Malaysian *F. jangomas* and at 3297 mg GAE/100 g for Indian coffee plum (21, 24). Another report showed that contents of total phenolic and flavonoid were 20 mg GAE/g and 2 mg QE/g (5). The carotenoids content was 1.2 mg/100 g in Indian coffee plum, while Vietnam Hong Quan fruit was 9.87 mg/100g of fresh weight. Besides, the content of tannin and alkaloids were also high at 944.08 mg TAE/100 g and 586.68 mg CE/100 g of fresh weight. The saponin was observed at 20.87 mg SE/100g fresh weight.

There was difference in the amounts of chemical components and bioactive compounds of this study result with some other ones. This can explain that analysis methods are different and environmental factors and growing conditions of plants affect secondary metabolites and chemical composition (25, 26). Environment conditions such as temperature, rainfall and relative humidity of the plant, they also have the ability to change the genic characteristics of the plant, these elements may be directly affected by metabolite changes during plant growth (27). Hong Quan fruit is a good source of bioactive compounds in both quantity and quality. These bioactive components could be exploited in both food and cosmetic industry.

Antioxidant activity of ethanol extract from Hong Quan fruit

There are various *in vitro* methods to determine the antioxidant ability of fruit because antioxidants reply differently to different radical and oxidant sources. A single on method could not surely express all the radicals and antioxidants in complex matrixes. In general, the most important *in vitro* tests are based on two major mechanisms: the hydrogen atom transfer methods, which measure the ability to scave free radicals by hydrogen offering, and the single electron transfer methods, which find the ability to transfer one electron to reduce a compound such as free radicals and metals (28). Antioxidants are important component that decrease the risk of chronic diseases by scavenging free radicals accumulated on cell tissues, thereby preventing them from oxidative damage (20).

The antioxidant activity of Hong Quan fruit was evaluated base on the ability of the fruit extracts to scavenge 2,2-diphenyl-1- picrlyhydrozyl free radicals (DPPH), to reduce ferric ions determined by ferric reducing antioxidant potential (FRAP) assay and to assess total reducing power by determined antioxidant ability index (AAI). Result was showed in Table 3. The present work, showed that the DPPH assay of the crude ethanol extract was quite high at 88.65% and the FRAP assay was 15.24 mM FeSO4/100g. Meanwhile, the ability of scavenging free racdicals DPPH of leaves, stems, flowers and seeds extract of *Malva sylvestris* were 93.11%, 98.52%, 93.70% and 91.08% respectively (29). The iron reduction capacity of some plants with different extraction solvents ranged from 16,357 to 404,123 gFeSO4/100g extract (30). Besides, the antioxidant index (AAI) of Hong Quan fruit was 8.13. The results of the study evaluating the total reducing capacity of tea variety (*Camelia sinensis*) grown at different heights were from 70.69÷142.31 µM ascorbic acid/g fresh leaves (31). The iron reduction capacity of phenolic and flavonoid extracts from *Malva sylvestris* was 0.04 to 0.15 and 0.05 to 0.59 µM Fe^{2+}/mg dry extract respectively (29).

Table 3. Antioxidant ability of crude extract form Hong Quan fruit

No.	Assessment method	Results (Mean ± SD, n = 6)
1	DPPH (%)	88,65 ± 1.23
2	FRAP (mM $FeSO_4$/100g)	15.24 ± 0.26
3	AAI	8.13 ± 0.82

Conclusion

Hong Quan fruits are enough of nutritious components as carbohydrate, total sugar, protein, lipid, crude fibre and ash; and have various antioxidants as flavonoids, phenolics, tannin, alkaloids, saponins, carotenoids and vitamin C. These substances are very necessary for human health and they are ability to destroying free radicals in body, so can reduce the risk of chronic diseases. Some substances have high content such as phenolic 456.32 ± 23.81 mgGAE/100g, alkaloids 586.68 ± 44.56 mgCE/100g, tannin 944.08 ± 26.31 mgTAE/100g. Other substances have low content as flavonoids 65.95 ± 2.92 mgQE/100g, saponin 20.87 ± 2.00 mgSE/100g, carotenoids 9.87 ± 0.40 mg/100g fresh weight. The ethanol extract of fruit are antioxidant ability at high level as DPPH 88.65 ± 1.23%, FRAP 15.24 ± 0.26 mM $FeSO_4$/100g and AAI 8.13 ± 0.82. Further researches could determine effects of processing methods on nutritional and functional components of Hong Quan fruits.

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Authors contributions

NDT designed, carried out the experiment, analysed data, wrote, reviewed and edited. VTXT and TNK carried out the experiment and analysed data. All authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest: **:** Authors do not have any conflict of interests to declare.

Ethical issues: None

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