Academia Journal of Agricultural Research 6(10): 346-353, October 2018
D OI: 10.15413/ajar.2018.0144
ISSN: Academia 2315-7739

Research Paper

An overview of Taro (*Colocasia esculenta*): A review

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Accepted 16th October, 2018

ABSTRACT

Colocasia esculenta is a tropical plant grown primarily for its edible corms, roots and vegetables. It is most commonly known as taro and is widely cultivated in the high rainfall areas under flooded condition usually by small farmers. This study provides details about morphological characters of taro and their use as food, region and season of cultivation.

Key words: Taro, edible, medicinal, morphology.

INTRODUCTION

Herbs are predominantly used to treat cardiovascular, liver, central nervous system (CNS), digestive and metabolic disorders. Given their potential to produce significant therapeutic effect, they can be useful as drug or supplement in the treatment or management of various diseases. Herbal drugs or medicinal plants, their extracts and isolated compounds have demonstrated a wide spectrum of biological activities. Selection of scientific and systematic approach for the biological evaluation of plant products based on their use in the traditional system of medicine forms the basis for an ideal approach in the development of new drugs from plants (Arulmozhi, 2007). One such plant is *Colocasia esculent* Linn.

Taro (*C. esculent* Linn.) is a vegetative propagated tropical root having its origin from South-east Asia. It occupies 9th position among world food crops with its cultivation spreaded across Africa. Taro tubers are important sources of carbohydrates as an energy source and are used as staple foods in tropical and sub-tropical countries. It is largely produced for its underground corms containing 70 to 80% starch. There are numerous root and tuber crops grown in the world. Taro is one of such crops grown for various purposes. It is an erect herbaceous perennial root crop widely cultivated in tropical and sub-tropical world belonging to the genus *Colocasia* in the plant family called Araceae (Macharia, 2014).

The crop is largely produced in Africa even though the time of its spread to the region is unknown and nowadays cultivated in Cameroon, Nigeria, Ghana and Burkina Faso where it has gained high importance (Chaïr, 2016). It has been suggested that the crop was cultivated to fill seasonal food gaps with other crops still in the fields because of its potential in giving reasonable yield under conditions where other crops may be unable to give produce by various crop production constraint (Tewodros, 2013).

The corm of taro is relatively low in protein (1.5%) and fat (0.2%) and this is similar to many other tuber crops. It is a good source of starch (70 to 80 g/100 g dry taro), fiber (0.8%), and ash (1.2%). Taro is also a good source of thiamine, riboflavin, iron, phosphorus and zinc and a very good source of vitamin B_6, C, niacin, potassium, copper and manganese (Quach, 2003).

Taro can also be used for entrapment of flavouring compounds (Tari and Singhal, 2002). It is locally referred to as "*brobey*" and cultivated on subsistence basis for its cormels and leaves, which are boiled and eaten. In other parts of the world, taro is made into ice cream and drinks (Qiwei and Qingdian, 2000). Taro leaves and tubers are poisonous if eaten raw; the acrid calcium oxalate they contain must first be destroyed by heating.

Table 1: Different vernacular names of *Colocasia esculenta*.

S/No	Names	Language
1	Taro	English
2	Aravi	Hindi
3	Alupam	Sanskrit
4	Alavi	Gujarati
5	Alu	Marathi
6	Sempu	Tamil

Table 2: Botanical classification of Taro (*Colocasia esculenta*).

Rank	Scienticfic name
Kingdom	*Plantae* (Plants)
Sub-kingdom	*Tracheobionta* (Vascular plants)
Super division	*Spermatophytes* (Seed plants)
Division	Magnoliophyta (Flowering plants)
Class	Liliopsida (Monocotyledons)
Subclass	Arecidae
Order	Arales
Family	Araceae (Arum family)
Genus	*Colocasia Schott* (*Colocasia*)
Species	*Colocasia esculenta* (L.) Schott (Cocoyam)
Synonyms	Alocasia dussil Dammer Alocasia illustris W. Bull

Taro is rich in digestible carbohydrates and micronutrients (Vinning, 2003). Taro contains anti-nutrient factors such as: oxalate, phytate and tannin. Taro deteriorates rapidly as a result of its high moisture and has been estimated to have a shelf-life of up to one month if undamaged (Lebot, 2009) and stored in a shady area. Taro foods are useful to persons allergic to cereals and can be consumed by infants/children who are sensitive to milk.

Studies conducted in Asia in the past reported that babies who were fed poi-a type of baby food prepared from taro were found to suffer less from health conditions such as diarrhea, pneumonia, enteritis and beriberi than babies fed with rice and bread (Miller, 1971). The nutritive value of poi as being hypoallergenic, rich in calcium, potassium, phosphorus, magnesium, vitamins B, A and C and high in fiber serves as a slow release energy food source. Apart from the vast uses of taro for food, it can also be used as an additive to render plastics biodegradable (Linden, 1996). Taro has a small starch grain about a tenth of that of potato (1 to 6.5 μm) making it more digestible.

Taro is known to be a good source of carbohydrate, fiber and minerals especially potassium and vitamins (especially B-complex) which is more than that found in whole milk and vitamins A and C. It is rather low in ascorbic acid and carotene with the amount of carotene being the same level as that found in cabbage and twice that found in potato (Wang, 1983).

TAXONOMY AND MORPHOLOGY OF TARO

Taxonomy

(C. esculenta L.) known as Taro belongs to the family Araceae. Linnaeus originally described two species which are now known as *C. esculenta* and *Colocasia antiquorum* of the cultivated plants. Taro is related to *Xanthosoma* and *Caladium*, plants commonly grown as ornamentals, and like them it is sometimes loosely called elephant ear. Taro is made up of at least 100 genera and more than 1500 species (Mandal, 2013). It has been reported as corms of the wild taro which cannot be used as food due to an extremely high concentration of calcium oxalate crystals (Quero-Garcia, 2006). The specific epithet, esculenta, means "edible" in Latin. Taro is related to *Xanthosoma* and *Caladium*, plants commonly grown as ornamentals, and like them it is sometimes loosely called elephant ear. Table 2 shows the botanical classification of Taro (*C. esculenta*).

Morphology

Taro is naturally a perennial monocotyledonous herb,but for practical purposes is harvested after 5 to 12 months of

Table 3: Nutrition value of leaves.

Nutrition facts of leaves	
Principle	**Nutrient value**
Calories	42
Fats	0.7 g
Saturated fat	0. 2 g
Sodium	3 mg
Carbohydrates	6.7 g
Dietary Fiber	3.7 g
Sugar	3 g
Protein	5 g
Vitamin A	96%
Vitamin C	87%
Calcium	11%
Iron	12%

growth (Mwenye, 2009). It grows to a height of 1 to 2 m consisting of a central corm, lying just below the soil surface, from which leaves grow upwards, roots grown downwards, while cormels, daughter corms and runners grow laterally (Ubalua, 2016). It has heart-shaped green or purple leaves together with long petioles, fibrous roots and cylindrical or often irregular nutrient storage organ (corm) and the nature of flowering, fruiting and seed production by wild or cultivated taros (*Colocasia esculenta*) has not been fully understood (Matthews, 2012). Female inflorescence is short, while male inflorescence is long, cylindrical and usually interposed neuters between the two. Appendix is erect, elongate-conical or fusiform, subulate or abbreviate. Male flowers are 3 to 6 androus in nature (Kirtikar and Basu, 2005). However, Castro (2006) reported that taro seldom flowers and when flowers occurs the inflorescence consists of a cylindrical spadix of flowers enclosed in a 12 to 15 cm spathe resulting unisexual with the female flowers located at the base of a spadix and the male flowers at the top.

Genetic diversity in Taro

Mace and Godwin reported diploids (2n=2x=28) and triploids (2n=3x=42) chromosomes in taro while diversity study using simple cytological techniques (Mace and Godwin, 2002). Taro chromosome number is 2n=14, 28, and 42 and 2n=36 and 48 in India; it is suggested that the genetic instability might be due to cultivation for long period of time in the region of center of diversity (Dastidar, 2009). Quero-Garcia et al. (2006) stated that taro is highly polymorphic, allogamous and a protogynous species.

Morphological characterization of taro

Morphological taro characterization can be done based on its corm, stolon, leaf, petiole and floral characters and other quantitative traits. According to Lebot (2010), there was high morphological variability in taro accessions in Southeast Asia and Oceania. The variability with regard to morphological traits includes colour, shape and size of tuber, petiole length and colour, and stolon formation. Moreover, Manzano (2001) reported presence of greatest morphological variability in root colour, cormel flesh colour, corm dry matter percentage, corm shape and cormel shape in Colocasia esculenta collected from Asia, Africa and America.

Leaf

The taro leaves rich in protein content (23%) might be favourably complemented with the high carbohydrate contents (87%) found in the tuber part of the plant as a source of human food (Annan and Plahar, 1995). The leaves of taro have been reported to be rich in minerals like Ca, P, Fe and vitamins. The high level of dietary fibre found in the taro leaf are also advantageous for their active roles in the regulation of intestinal transit, increasing dietary bulk and faeces consistency due to their ability to absorb water (Dubois and Savage, 2006).

Root

Nutritionally, roots and tubers have a great potential to provide economical sources of dietary energy, in the form of carbohydrates (Table 4), while Table 5 shows the geographical distribution of Taro production. Figure 1 shows taro tubers, while Figure 2 shows taro leaves and Figure 3 taro plant. The energy from tubers is about one-third of that of an equivalent weight of rice or wheat due to high moisture content of tubers. However, high yields of

Table 4: Nutrition value of Taro root RDA (Recommended Dietary Allowances).

Principle	Nutrition value per 100 g	
	Nutrient value	**Percentage of RAD**
Energy	112 kcal	6
Carbohydrates	26.46 g	20
Protein	1.50 g	3
Total fat	0.20 g	<1
Cholesterol	0 mg	0
Dietary fibres	4.1 g	0
Vitamins		
Folates	22 µg	5.5
Niacin	0.600 mg	4
Pantothenic acid	0.303 mg	6
Pyridoxine	0.283 mg	23
Riboflavin	0.025 mg	2
Thiamin	0.095 mg	8
Vitamin A	76 IU	2.5
Vitamin C	4.5 mg	7
Vitamin E	2.38mg	20
Vitamin K	1 µg	1
Electrolytes		
Sodium	11 mg	<1
Potassium	591 mg	12.5
Minerals		
Calcium	43 mg	4
Copper	0.172 mg	19
Iron	0.55 mg	7
Magnesium	33 mg	8
Manganese	0.383 mg	1.5
Selenium	0.7 µg	1
Zinc	0.23 mg	2

Source: USDA National Nutrient data base.

Table 5: Geographical distribution of Taro production.

Top taro producer of 2014 (million metric tons)	
Countries	**Value**
Nigeria	3.3
China	1.8
Cameroon	1.6
Ghana	1.3
Papua New Guinea	0.3
World total	10.2

roots and tubers give more energy per land unit per day as compared to cereal grains.

In general, the protein content of roots and tubers is low ranging from 1 to 2% on a dry weight basis (FAO, 1990). The corm of taro contains more than twice the carbohydrate content of potatoes and yield 135 k cals per

Figure 1: Taro tubers.

Figure 2: Taro leaves.

100 g and 11% crude protein on a dry matter (DM) basis. These reported carbohydrate and protein values are even higher than other root crops like yam, cassava or sweet potato (FAO, 1999). Though, protein and fat content of taro are low, but is high in carbohydrates, fiber and minerals (Del Rosario and Lorenz, 1999). It contains 85 to 87%

Figure 3: Taro plant.

starch on a DM basis with small granule size of 3 to 18 µm and other nutrients such as zinc, vitamin C, thiamine, riboflavin and niacin are higher than other root crops (Jirarart, 2006).

Nutritional value of Taro

Carbohydrate (expressed as nitrogen free extract, NFE) content reported was estimated by subtracting the moisture, crude protein, ash, fiber and fat from 100 (Table 3). Zinc and iron content was analyzed following the AOAC (1990) dry ashing procedure and standard analytical method for atomic absorption spectrophotometry (Association of official analytical chemists, 1990).

Phytochemical contents

The total phenolic content was determined by the Folin-Ciocalteu Assay while the total tannin analysis was conducted using the modified vanillin method. The total flavonoid concentration was measured using a colorimetric assay developed by Zhishen (1999).

Carbohydrate

The high level of carbohydrate content observed in raw taro, taro powder, noodles and cookies agrees with the findings reported by FAO (1990) that the main nutrient supplied by taro, as with other roots and tubers, is dietary energy provided by the carbohydrates (Ndabikunze, 2011).

Starch

Taro corm has been reported to have 70 to 80% (dry weight basis) starch with small granules. Because of the small sizes (1 to 4 m in diameter) of its starch granules, taro is highly digestible and as such has been reported to be used for the preparation of infant foods in Hawaii and other Pacific islands (Jane, 1992). Taro starch is easily digestible; the starch grains are fine and very small, it has hypoallergenic nature and the starch is also gluten free (Kochha, 1998). Taro starch is also good for peptic ulcer patients, patients with pancreatic disease, chronic liver problems and inflammatory bowel disease and gall bladder disease (Emmanuel-Ikpeme, 2007). The most important sugar in taro is sucrose, but fructose, maltose, glucose and raffinose are also present. Malic acid is the most important organic acid (60%) followed by citric acid (25%) and oxalic acid (15%) (Arnavid-Vinas and Lorenz, 1999).

Moisture

Since taro is a root crop, its moisture content is very high and accounts two third of the total weight of the fresh crops (FAO, 1999). Moisture content of taro varies with variety, growth condition and harvest time. In general, the moisture content of taro ranges from 60 to 83% (Huang and Tanudjaja, 1992).

Protein

Taro is composed of high protein than other root crops due to the presence of symbiotic soil bacteria in the root and rhizome part of taro. These bacteria fix atmospheric bacteria and increase nitrogen occurrence in the corm and leaves. More often the bacteria are used as plant growth enhancer due to release of growth hormone to the roots and distributed to the whole part of the plant. The free-living nature of this soil bacterial also helps the taro crop to grow at different environmental and ecologic conditions. These properties have economic and ecologic importance to the environment (Lucy, 2004).

Total ash

Taro contains fairly high amount of ash from which it can be inferred it contains good mineral contents. The ash contents of taro ranged from 3.54 to 7.78% (Maksimov, 2011).

Phytochemicals

Taros have high amount of β-carotene in the corm and will impart vitamin A and antioxidant property in the body. B-carotene differs only very slightly in terms of structure. They are very common in carotenoids and are antioxidants, as well as, having other potential health benefits. As mentioned earlier, both can be converted into vitamin A by the body, though β-carotene has about twice the provitamin A activity as α- carotene (Nip, 1997).

Phenolic acids

Taro tubers are rich in starch and the tubers contain anthocyanins and cyanidin 3-glucoside. In common with flavonoids, the related anthocyanins are reputed to improve blood circulation by decreasing capillary fragility to improve eyesight, act as potent antioxidants, anti-inflammatory agents and also to inhibit human cancer cell growth (Wagner, 1985). It has been reported that flour from taro corms, dried and milled contains easy digestion starch and is therefore widely used as infant food (Del Rosario and Lorenz, 1999).

It is also used for anthocyanin study experiments especially with reference to abaxial and adaxial anthocyanic concentration (Hughes, 2014).

Oxalic acid / oxalates

Oxalates are one major limiting factor in the utilization of taro is the presence of oxalates which impart acrid taste or cause irritation when raw or unprocessed foods from them are eaten. This acridity is caused by needle–like calcium oxalate crystals and raphides that can penetrate soft skin (Bradbury and Nixon, 1998).

Anti-cancer activities

Cancer is a leading cause of death worldwide, and it is mostly related to unhealthy food habits and lifestyle. It is important to find ways to reduce and prevent the risk of cancer through dietary components, which are present in plant foods. Cancer is a multi-stage disease condition and tapping at any initial stage could help attenuate the disease condition. Root and tuber phytochemicals demonstrated anti-cancer effects in several types of carcinoma cell lines and animal models (Huang, 2004).

Conclusion

Many root and tuber crops are grown throughout the world in hot and humid regions for their use as vegetable as most of them contain starch as the major carbohydrate in them. They are important diet component for humans and add variety to it. Taro (*C. esculenta*) is one of the staple roots and tuber crop grown for various purposes. Taro tubers provide a number of desirable nutritional and health benefits such as anticancer activity, phenolic acid and phytochemicals. In this review there are important informations about the nutritional importance of taro and some of the health benefits of taro corms and leaves. Taro is used as a staple food or subsistence food by millions of people in many of the developing countries. The corms of taro are used as vegetable and considered as a rich source of carbohydrates, proteins, minerals, and vitamins. Taro tubers contain 70 to 80% of starch in them. It contains small granules which are highly digestible. Taro can be grown as a root crop, leafy vegetable, as an ornamental and medicinal plant. It is a staple crop for many of south-eastern Asia. Taro is an emergent aquatic and semi-aquatic plant. The leaves of taro are consumed as sauces, purees, stews and soups.

REFERENCES

Annan NT, Plahar WA (1995). Development and Quality Evaluation of a Soy-Fortified Ghanaian Weaning Food. United Nations University Press, Tokyo.

Arnavid-Vinas MDR, Lorenz K (1999). Pasta products containing taro (Colocasza

Arulmozhi S et al (2007). Pharmacologicalactivites of Alstonia scholaris Linn. (Apocynaceae) – A Review. Pharmacog Rev. 1:163-70.

Association of official analytical chemists (1990). Official Methods of Analysis. (13th ed) Washington, DC, USA.

Bradbury JH, Nixon RW (1998). The acridity of raphides from the edible aroids. J. Sci. Food. Agric. 76:608–616.

Castro GR (2006). Studies on Cocoyam (Xanthosoma spp.) in Nicaragua, with emphasis on Dasheen mosaic virus. Doctoral thesis presented to Swedish University of Agricultural Sciences, Uppsala.

Chaïr H et al (2016). Genetic diversification and dispersal of Taro (Colocasia esculenta (L.) Schott). PLoS ONE. 11: 1-19.

Dastidar SG (2009). Colocasia esculenta: An account of its ethno botany and potentials. An M.Sc. Hesis presented to He University of Texas, Austin.

Del Rosario AV, Lorenz K (1999). Pasta products containing taro (Colocasia esculenta L. Schott) and chaya (Cnidoscolus Chayamansa L. Mcvaugh). J. Food Process Preserv. 23:1–20

Dubois M, Savage GP (2006). The effect of soaking and cooking on the oxalate content of taro leaves. Int. J. Food Sci. Nut.

Emmanuel-Ikpeme CA (2007). Storage stability and sensory evaluation of taro chips fried in palm oil, palm olein oil, groundnut oil, soybean oil and their blends. Pakistan J. Nutr. 6 (6): 570-575.

FAO (1999). Taro Cultivation in Asia and the Pacific, Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.

Faostat UN Food & Agriculture Organisation.

Food and Agriculture Organization FAO (1990). Roots, Tubers, Plantains and Bananas in Human Nutrition, vol. 24 of Food and Nutrition Series, Food and Agriculture Organization, Rome, Italy. pp.24.

Huang AS, Tanudjaja LS (1992). Application of anion exchange high-performance liquid chromatography in determining oxalates in taro (Colocasia esculenta (L.) Schott) corms. J. Agric. Food Chem. 40: 2123–2126.

Huang DJ (2004). Antioxidant and antiproliferative activities of sweet potato (Ipomoea batatas [L.] Lam "Tainong 57") constituents, Botanical Bulletin of Academia Sinica. 45(3): 179–186.

Hughes NM (2014). Photosynthetic costs and benefits of abaxial versus adaxial anthocyanins in Colocasia esculenta 'Mojito'". Planta. 240: 971–981. doi:10.1007/s00425-014-2090-6.

Jane J (1992). Physical and chemical studies of taro starches and flours. Cereal Chemistry. 69: 528–535.

Jirarart T et al (2006). Chemical and physical properties of flour extracted from taro (Colocasia esculenta) grown in different regions of Thailand. Science Asia. 32: 279–284.

Kirtikar KR, Basu BD (2005).Indian Medicinal Plants. Dehradun: International Book Distributors. 4: 2615.

Kochha S (1998). Economic Botany in the Tropics. MacMillan Indian Limitted. Delhi.

Lebot V (2009). Tropical root and tuber crops: cassava, sweet potato, yams, aroids, CAB International. pp. 279-360.

Lebot V et al (2010). Characterizing taro using isozymes and morpho-agronomic descriptors. He global diversity of taro, Biodiversity International, Rome, Italy. Pp. 39-55.

Linden G (1996). Analytical Techniques for Food and Agricultural Products, Wiley-VCH Publishers, USA.

Lucy ME (2004). Application of free living plant growth-promoting rhizobacteria. Antonie van Leeuwenhoek. 86: 1025.

Mace ES, Godwin ID (2002). Development and characterization of polymorphic microsatellite markers in taro (Colocasia esculenta). NRC Res. Press. 45: 823-832

Macharia WM et al (2014). Genetic structure and diversity of East African Taro Colocasia esculenta L. Afr. J. Biotechnol. 139: 2950-2955.

Maksimov IV (2011). Plant growth promoting rhizobacteria as alternative to chemical crop protectors from pathogens (Review). Appl. Biochem. Microbiol. 47:333-345.

Mandal R et al (2013). Assessment of genetic diversity in Taro using morphometrics. Curr. Agric. Res. J. 1: 79-85.

Manzano AR et al (2001). Morphological and isoenzyme variability of Taro (Colocasia esculenta L. Schott) germplasm in Cuba. He global diversity of Taro, Biodiversity International, Rome, Italy. Pp. 69-91.

Matthews PJ et al (2012). Ethnobotany and ecology of wild Taro (Colocasia esculenta) in the Philippines: Implications for domestication and dispersal. Senri. Ethnol. Stud. 78: 307-340.

Miller CD (1971). Food values of poi, taro and limu. Bernice P. Kraus reprint, Hawaii.

Mwenye OJ (2009). Genetic diversity analysis and nutritional assessment of Cocoyam genotypes in Malawi. An M.Sc. Thesis presented to University of Free State, Bloemfontein, South Africa.

Ndabikunze BK et al (2011). Proximate and mineral composition of cocoyam (Colocasia esculenta L. and Xanthosoma sagittifolium L.) grown along the Lake Victoria Basin in Tanzania and Uganda. African J. Food Sci. 5: 248-254.

Nip WK (1997). Taro root. In: D.S. Smith, J.N. Cash, W.K. Nip, Y.H. Hui, (eds.). Taro: Processing Vegetable and Technology. Technomic Publishing, Pensylvania, USA. pp. 355–387.

Qiwei H, Qingdian L (2000). Research & development of Shangdong taro for high-value products and exports'' In: D. Zhu, P. V. Eyzaguirre, M. Zhou, L. Sears and G. Liu (eds) Ethnobotany and genetic diversity of Asian taro: focus on China. Proceedings of the symposium on ethnobotanical and genetic study of taro in China: Approaches for the conservation and use of taro genetic resources. Laiyang Agricultural College, Laiyang, Shangdong, China, International Plant Genetic Resources Institute, Rome.

Quach ML et al (2003). Cell wall compositions of raw and cooked corms of taro (Colocasia esculenta). J. Sci. Food Agric. 81: 311–318.

Quero-Garcia J et al (2006). First genetic maps and QTL studies of yield traits of taro (Colocasia esculenta (L.) Schott). Euphytica. 151: 187-199.

Quero-Garcia J, Courtois B, Ivancic A, Letourmy P, Risterucci AM et al (2006). First genetic maps and QTL studies of yield traits of taro (Colocasia esculenta (L.) Schott). Euphytica. 151: 187-199.

Tari AT, Singhal RS (2002). Starch based spherical aggregates: Stability of a model flavoring compound, vanillin entrapped therein. Carbohydrate Polymers. 50: 417–421.

Tewodros M (2013). Genetic diversity of Taro (Colocasia esculenta (L.) Schott) genotypes in Ethiopia based on agronomic traits. Time J. Agric. Vet. Sci. 1: 23-30.

Ubalua AO et al (2016). Potentials and challenges of sustainable taro (Colocasia esculenta) production in Nigeria. J. Appl. Biol. Biotechnol. 4: 053-059.

Vinning G (2003). Select markets for taro, sweetpotato and yam. In: Rural Industries Report for Research and Development Corporation. RIRDC Publication No. 03/052, Kingston Act.

Wagner H (1985). New plant phenolics of pharmaceutical interest in: C.F. Van Sumere P J, Lea (Eds.), Annual Proceedings of Phytochemistry Society in Europe, The Biochemistry of Plant Phenolics, Clarendon Press, Oxford. 25: 401.

Wang JK (1983). Taro-a review of Colocasia esculenta and its potentials. University of Hawaii Press, Honolulu.

Zhishen J (1999). The determination of flavonoid contents in mulberry and their scavenging effects on superoxide radicals. Food Chem. 64: 555-559.