Taro Ice Cream: Addition of *Colocasia esculenta* Stem to Improve Antioxidant Activity in Ice Cream

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Abstract. *Colocasia esculenta* (*C. esculenta*) is a widely cultivated plant for consumption and traditional medicine. Recent evidences showed lack studies about the stem of *C. esculenta* as medicinal agent. Besides, ice cream is a food, which contains milk that play beneficial role as antioxidant. Addition of *C. esculenta* in ice cream may improve antioxidant activity by its phytochemical compounds. Thus, the aim of this nutritional food study is to determine the antioxidant activity, phytochemical compounds and nutritional minerals. The methods used were done by thin layer chromatography (TLC) test and antioxidant assays characterized using 2,2-diphenyl-1-picrylhydrazyl (DPPH). The nutritional minerals was also measured on the study. The results showed the extract had antioxidant activity that measured at 675.283pg/ml. The stem extract of *C. esculenta* positively contained Flavonoid, Terpenoid, Saponin, and Steroid based on TLC assays. Based on nutritional minerals test, *C. esculenta* contained vitamin C, vitamin E, Potassium, and % Calcium. Flavonoids, Terpenoid, Saponin, and steroid had been proved as potent treatment for oxidative stress. Vitamin C and E also had evidence as antioxidant properties. Activity of antioxidant enzymes were improved in Potassium and Calcium treatment studies. Therefore, the addition of *C. esculenta* in ice cream could improve the activity of antioxidant.

1. Introduction

Antioxidant is natural or man-made substance that can prevent or delay cell damaged caused by free radicals [1]. Antioxidants have an important role as protective agents against oxidative damage and scavenging reactive oxygen species [2]. Antioxidants can be found from natural source, such as fruits and vegetables that contains certain phytochemical compounds, such as lutein, beta-carotene, vitamin C and E, and the others [3]. Based on previous research, spices, herbs and supplements are included to the most antioxidants rich product [4].

In the other hand, Taro (*Colocasia esculenta* (L.) Schott), also known as eddoes or dasheen, which originated in the Bay of Bengal region of South-east Asia [5], had been known as one of antioxidant sources [6]. Taro is a vegetative propagated tropical root and important source of carbohydrates as and energy source [6]. 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 (70–80 g/100 g dry taro), fiber (0.8%), and ash...
Taro is also a good source of thiamine, riboflavin, iron, phosphorus, and zinc and a very good source of vitamin B6, vitamin C, niacin, potassium, copper, and manganese [6].

Besides, ice cream is a dairy product that is much loved by the public, especially children, because of its sweet taste, soft texture, and high nutritional value [7]. The nutritional content of ice cream in every 100 g contains 12.5 g of fat, 4 g of protein, 20.6 g of carbohydrates, and 0.1 mg of iron [8,9]. The use of milk is essential in the ice cream mixture, where its fat content has a function to enhance the taste, soften the texture, help shape the ice cream, and give good melting properties to the ice cream [10]. Also, milk as an essential ingredient makes ice cream potential to be developed as a probiotic food [11].

Probiotic is a living bacteria given as a food supplement for humans and animals by improving their balance of the gut bacteria [12]. However, in recent years there has been researched on probiotics that have benefits for preventing gastrointestinal diseases and have other potential benefits such as antioxidant activity [13]. Antioxidants are indispensable to the body to cope and prevent oxidative stress [14]. The new formulation of ice cream with C. esculenta may improve the antioxidant needs in human body. Thus, the aim of this nutritional food study is to determine the antioxidant activity, phytochemical compounds and nutritional minerals of taro ice cream, a new approach of antioxidant improvement in ice cream.

2. Methods
This research was conducted by analyzing the antioxidant activity of C. esculenta stalk extract using the free radical scavenging method in the Chemistry laboratory of The Indonesian Institute of Sciences (LIPI). This method was characterized by 2,2-diphenyl-1-picrylhydrazyl (DPPH) and used a standard compound in the form of Quercetin. The scavenging characterization of C. esculenta stalk extracts was calculated using present equation below, where Abscontrol was the absorbance of DPPH + ethanol; AbsSample was the absorbance of DPPH radical + sample.

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\text{Percentage of DPPH scavenging} = \frac{\text{Abs}_{\text{control}} - \text{Abs}_{\text{sample}}}{\text{Abs}_{\text{control}}} \times 100
\]

(1)

The phytochemical compound test on the stalk extract of C. esculenta was carried out using the thin layer chromatography (TLC) method at the Faculty of Pharmacy, Gadjah Mada University. Furthermore, ice cream was made with the formulation of 600 grams of C. esculenta, 30 grams of skim milk powder, 30 grams of vegetable creamer, 100 grams of granulated sugar, 150 ml of liquid milk, and
750 ml of water. Furthermore, we analysed the mineral nutrients, which were vitamin C, vitamin E, potassium and calcium, using spectrophotometry analysis and repeated twice.

3. Results

3.1. Antioxidant Activity
The result of antioxidant activity was shown in table 1 and figure 1. The data showed that the antioxidant activity of the extract was \( IC_{50} = 675.283 \). It meant that *C. esculenta* stem extract takes ± 675.283pg / mL to show the antioxidant activity (with the DPPH test as free radical). When it was compared to antioxidant activity of Quercetin, which had \( IC_{50} = 2.4 \), the antioxidant activity of *C. esculenta* stem extract was still included to low intensity. The difference in the antioxidant activity of these compounds could be caused by the differences in the characteristics of the tested compounds. Quercetin is a single compound and the *C. esculenta* stem extract is still a common extract.

| No | Sample | Absorbance | Concentration (ppm) | Inhibition (%) | \( IC_{50} \) (pg/mL) |
|----|--------|------------|---------------------|---------------|----------------------|
| 1  | Blanco | 1.8326     |                     |               |                     |
| 2  | Extract| 1.1661     | 400                 | 36.369        | 675.283             |
|    |        | 1.3053     | 200                 | 28.773        |                     |
|    |        | 1.437      | 100                 | 21.587        |                     |
|    |        | 1.5503     | 10                  | 15.404        |                     |

Figure 1. Linear Regression Graphic of *C. esculenta* Stem Extract Antioxidant Inhibition. Solid blue line showed linear regression result, solid black line showed standard compound and dotted black line showed log of the standard compound.

3.2. Phytochemical Compounds
Phytochemical compounds of *C. esculenta* stem were analysed by Thin Layer Chromatography (TLC) assay. According to table 2, *C. esculenta* stem extract contained flavonoid, saponin, steroid, and terpenoid. Saponin had proportion in the extract at the most based on the observed spot and highest restriction factor (RF) and steroid have highest hRx value compared to the comparison.
Table 2. Thin Layer Chromatography Result of C. esculenta.

| No. | Phytochemical Compund | Comparison | Result | Rf  | hRx |
|-----|-----------------------|------------|--------|-----|-----|
| 1.  | Alkaloid              | Quinin     | -      | -   | -   |
| 2.  | Flavonoid             | Quercetin  | +      | -   | -   |
|     |                       | Rutin      | +      | -   | -   |
| 3.  | Saponin               | Saponin    | ++     | 0.594 | 71 |
| 4.  | Tannin                | Tannin     | -      | -   | -   |
| 5.  | Steroid               | Stigmasterol| +      | 0.45 | 83.72 |
| 6.  | Phenol                | Gallic Acid| -      | -   | -   |
| 7.  | Terpenoid             | Tymol      | +      | 0.125 | 28.6 |

3.3. Nutrient Compounds

Taro stem ice cream were conducted within formulation ratio 6:1 of C. esculenta powder and sugar. Then, we analyzed the potential antioxidant compound of its mineral nutrients, which were vitamin C, vitamin E, potassium and calcium, using spectrophotometry analysis and repeated twice. The results of antioxidant mineral nutrients could be seen on table 3.

Table 3. Antioxidant Mineral Nutrients of Taro Ice Cream.

| Nutrient    | 1st test       | 2nd test       | Average       |
|-------------|----------------|----------------|---------------|
| Vitamin C   | 658.62 mg/100 gr | 614.7 mg/100 gr | 636.66 mg/100 gr |
| Vitamin E   | 0.5834 %       | 0.5946 %       | 0.589 %       |
| Potassium   | 0.2374 %       | 0.3391 %       | 0.288 %       |
| Calcium     | 3.1393 %       | 3.2241 %       | 3.018 %       |

Based on nutritional minerals test that was done at Center for Food and Nutrition Studies, Universitas Gadjah Mada, C. esculenta contained vitamin C as much as 636.66 mg/100 gram samples. It also contained 0.589 % vitamin E, 0.288 % Potassium, and 0.318 % Calcium. These data showed that addition of taro stem could increase nutritional mineral on ice cream.

4. Discussion

C. esculenta is widely cultivated plant worldwide, especially in Indonesia. It has been reported that the leaf, tuber, and root of C. esculenta had potential role in various pharmaceutical activities [15]. But, there were still lack of information about C. esculenta stem nutrition and pharmaceutical activities. Recent studies showed that C. esculenta stem extract had an antioxidant activity in certain concentration. Antioxidants are molecules that could neutralize and limiting the process of free radical oxidation by terminating the chain reactions [16,17]. These free radicals are the cause of various health problems, such as aging, inflammatory diseases, cancers, and many others [18,19]. In this study, we characterized the antioxidant compounds by the phytochemical compounds of C. esculenta stem extract and mineral nutrients of ice cream, which added by C. esculenta stem formulation.

The first results showed that C. esculenta stem extract positively contained Flavonoid, Saponin, Steroid, and Terpenoid. Previous studies reported that Flavonoid acted as antioxidant [20], anti-inflammatory [21], anti-mutagenic [22], and anti-carcinogenic [23] properties to improve human health [24]. Saponin were also known as antioxidant properties that plays a role as hepato-protective, anti-tumor, anti-microbial, and anti-inflammatory activities [25]. Mooradian [26] also stated that some steroids had been related to significant antioxidant activities, such as 17β-estradiol, 17α-estradiol and estriol. Furthermore, other study also revealed the antioxidant activities of terpenoid [27]. These phytochemical compounds may represent the antioxidant properties of C. esculenta stem extract.

The result of mineral nutrient assays showed that the formulation of C. esculenta stem in ice cream contained potential antioxidant compound, which were vitamin C, vitamin E, potassium and calcium.
Several studies revealed the role of vitamin C as antioxidant agent that could prevent human diseases such as cardiovascular disease and cancer [28,29,30]. Vitamin E was also reported to play a significant role as antioxidant agent [31]. It had a function to protect long chain poly-unsaturated fatty acids and thus maintain their concentrations for important signaling events against free radicals process [31]. Other previous study also showed the result of potassium and calcium roles as antioxidant properties. The research showed that potassium and calcium could enhance the activity of antioxidant enzymes, which activates more than 50 enzymes [32]. These facts represent the potential role of C. esculenta stem formulation in ice cream to improve its antioxidant activity based on its mineral nutrients.

5. Conclusion
This study revealed the antioxidant activity C. esculenta stem extract (IC_{50} = 675.283) but still included to low intensity. The antioxidant activity of C. esculenta stem extract may be regulated by its phytochemical compounds that were Flavonoid, Saponin, Steroid, and Terpenoid. The addition of C. esculenta stem formulation in ice cream also could improve the activity of antioxidant by mineral compounds, which were vitamin C, vitamin E, potassium and calcium.

References
[1] Lobo V, Patil A, Phatak A, Chandra N 2010 Free radicals, antioxidants and functional foods: Impact on human health Pharmacogn Rev 4(8):118–26.
[2] Colville L. Seed Storage. In: Thomas B, Murray BG, Murphy DJBT-E of APS (Second E, editors. Oxford: Academic Press; 2017. p. 335–9. Available from: http://www.sciencedirect.com/science/article/pii/B9780123948076000800
[3] Chun O, Frei B, Gardner C, Alekel D, Killen J. Antioxidants in depth [Internet]. NCCIH. 2013. Available from: https://www.nccih.nih.gov/health/antioxidants
[4] Carlsen M H, Halvorsen B L, Holte K, et al 2010 The total antioxidant content of more than 3100 foods, beverages, spices, herbs and supplements used worldwide Nutr J. 9:3. Published 2010 Jan 22. doi:10.1186/1475-2891-9-3
[5] O’Hair S K, Maynard D N VEGETABLES OF TROPICAL CLIMATES | Edible Aroids. In: Caballero BBT-E of FS and N (Second E, editor. Oxford: Academic Press; 2003. p. 5970–3. Available from: http://www.sciencedirect.com/science/article/pii/B012227055X012451
[6] Rashmi, Raghu, Gopenath, Palanisamy P, Bakhavatchalam P, Karthikeyan M, et al 2018 Taro (Colocasia esculenta): An overview J Med Plants Stud. 6(4):156–61.
[7] Simonungkalit H, Indriyani, Ulyarti 2016 Kajian Pembuatan Es Krim dengan Penambahan Kacang Merah (Phaseolus vulgaris L) Jurnal Penelitian Universitas Jambi Seri Sains 18(1):20-26.
[8] Astawan, M 2010 Teknologi pengolahan pangan dan gizi IPB (Bogor)
[9] Sandijaya A 2009 Kamus Ilmu Gizi Jakarta : PT Kompas Media Nusantara
[10] Octadayani E 2011 Pengaruh Subtitsusi Ubi Jalar (Ipomea batatas) dengan Susu Skim terhadap Pembuatan Es Krim Faperta Universitas Hasanuddin (Makassar). Skripsi
[11] Saputri E 2015 Pembuatan Es Krim Fungsional Dengan Bahan Baku Soyghurt dan Susu Rendah Lemak Jom Faperta 3(1)
[12] Fuller R 1999 Probiotics a Critical Review. Wymondham, UK: Horizon Scientific, Probiotics for farm animals pp. 15–22.
[13] Daliri E B-M, Lee B H. New perspectives on probiotics in health and disease. Food Sci Hum Wellness [Internet]. 2015;4(2):56–65. Available from: http://www.sciencedirect.com/science/article/pii/S2213453015000300
[14] Kemenkes RI 2014 Peran Antioksidan Bagi Kesehatan Pusat Biomedis dan Teknologi Dasar Kesehatan BaliBengkeng. Kemenkes RI
[15] Pawar H A, Choudhary P D, Kamat S R 2018 An Overview of Traditionally Used Herb, Colocasia
esculenta, as a Phytomedicine. Med Aromat Plants 07(02):1–7.

[16] Lakhtakia R, Ramji MT, Lavanya K, Rajesh K, Jayakumar K, Sneha C, et al 2011 The role of antioxidant in human health maintenance: Small molecules with infinite function Int J Pharm Sci Res 2(6):1394–402.

[17] Kattappagari K K, Teja C S R, Kommalapati R K, Poosarla C, Gontu S R, Reddy B V R 2015 Role of antioxidants in facilitating the body functions: A review J Orofac Sci. 7(2):71–5.

[18] Harman, D 1956 Aging: a theory based on free radical and radiation chemistry Journal of Gerontology 11 298–300.

[19] Dreher D, Junoda A F 1996 Role of oxygen free radicals in cancer development European Journal of Cancer 32 30-38.

[20] Srivastava N & Bezwada R 2015 Flavonoids: The Health Boosters. White Paper. Hillsborough, NJ: Indofine Chemical Company

[21] Hossain H, Jahan I A, Nimmi I, Hasan K 2012 Evaluation of Antinociceptive and Antioxidant Potential from the Leaves of Spilanthes paniculata Growing in Bangladesh Int J Pharm Phytopharm Res 1(178):178–86.

[22] Snijman P, Swanevelder S, Joubert S, et al 2007 The antimutagenic activity of the major flavonoids of rooibos (Aspalathus linearis): some dose–response effects on mutagen activation–flavonoid interactions Mutat Res 631: 111–123.

[23] LeJeune T M, Tsui H Y, Parsons L B, et al. 2015 Mechanism of action of two flavone isomers targeting cancer cells with varying cell differentiation status PLOS ONE 10: e0142928.

[24] Panche A N, Diwan A D, Chandra S R 2016 Flavonoids: an overview J Nutr Sci 5:e47. Published 2016 Dec 29. doi:10.1017/jns.2016.41

[25] Barky A El, Hussein S A 2017 Saponins-and-Their-Potential-Role-in-Diabetes-Mellitus Diabetes Manag 7:148–58.

[26] Mooradian A D 1993 Antioxidant properties of steroids J Steroid Biochem Mol Biol 45(6):509–11.

[27] Graßmann J 2005 Terpenoids as Plant Antioxidants Vitam Horm 72(05):505–35.

[28] Buettner G R 1993 The pecking order of free radicals and antioxidants: lipid peroxidation, alphatocopherol, and ascorbate Arch Biochem Biophys 300:535–543.

[29] Halliwell B 1999 Vitamin C: poison, prophylactic or panacea? Trends Biochem Sci 24:255–259.

[30] Padayatty S J, Katz A, Wang Y, Eck P, Kwon O, Lee J H, Chen S, Corpe C, Dutta A, Dutta S K, Levine M 2003 Vitamin C as an antioxidant: evaluation of its role in disease prevention J Am Coll Nutr Feb;22(1):18-35. doi: 10.1080/07315724.2003.10719272. PMID: 12569111.

[31] Traber M G, Atkinson J 2007 Vitamin E, antioxidant and nothing more Free Radic Biol Med 43(1):4-15. doi:10.1016/j.freeradbiomed.2007.03.024

[32] Siddiqui M H, Al-Whaibi M H, Sakran A M, Basalah M O, Ali H M 2012 Effect of calcium and potassium on antioxidant system of Vicia faba L. Under cadmium stress Int J Mol Sci 13(6):6604-6619. doi:10.3390/ijms13066604